The Impact of Innovation and the Role of Intellectual Property Rights on U.S. Productivity, Competitiveness, Jobs, Wages, and Exports

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ABSTRACT

This report analyzes the economic impacts of innovation and IP protection on the U.S. economy. Findings of the report demonstrate innovation is a crucial driver of competitiveness, growth, and value. Consequently, IP-intensive industries create jobs and spur economic growth as results from high investments in research and development (R&D). Data of 27 U.S. exportable and importable industries during 2000-07 shows: (1) IP-intensive industries created highly-skilled jobs during the entire business cycle and low-skilled jobs during the economic downturns while non-IP-intensive industries lost jobs in all levels; (2) IP-intensive industries paid their highly- and low-skilled employees nearly 60 percent more than non-IP-intensive industries; (3) Output and sales per employee in IP-intensive industries were more than double that of non-IP-intensive industries; (4) IP-intensive industries promoted exports and enhance competitiveness; (5) IP-intensive industries generated trade surplus and therefore reduced U.S. trade deficits; (6) IP-intensive industries spent almost 13 times the on R&D expenditure per employee that non-IP-intensive industries spent, which directly creates jobs and economic activities in R&D industries as well as in their supporting industries; and, (7) IP-intensive industries allocated over 2.2 times on capital expenditures per employee that non-IP-intensive industries, did which in turn stimulated jobs and economic activities in the U.S. economy. As such, protecting the intellectual property derived from innovation is essential to the future of a wide range of American industries.

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EXECUTIVE SUMMARY

Creativity and innovation are critical to the success of business, industry, and the economy. When ideas are developed into constructive goods and services and are protected through strong intellectual property (IP) rights, consumer interest and demand are spurred. As a result, jobs are created, economies grow, and societies advance. Studies have shown that innovation magnified growth during the upturns and led economies out of downturns.

This report reconfirms these maxims. In brief, our findings showed that of over two dozen U.S. tradable industries during 2000-07[1] : (1) IP-intensive industries created highly-skilled jobs during the entire business cycle and low-skilled jobs during the economic downturns while non-IP-intensive industries lost jobs in all levels; (2) IP-intensive industries paid their highly- and low-skilled employees nearly *60 percent more* than non-IP-intensive industries; (3) Output and sales per employee in IP-intensive industries were *more than double* that of non-IP-intensive industries; (4) IP-intensive industries promoted exports and enhance competitiveness; (5) IP-intensive industries generated trade surplus and therefore reduced U.S. trade deficits; (6) IP-intensive industries spent almost *13 times more* on R&D expenditure per employee than non-IP-intensive industries; and, (7) IP-intensive industries allocated over *2.2 times* the amount on capital expenditures per employee that non-IP-intensive industries allocated, which in turn stimulated jobs and economic activities in the U.S. economy. As such, protecting the intellectual property derived from innovation is essential to the future of a wide range of American industries.

The protection and enforcement of IP rights are imperative for creating strong incentives for innovation and safeguarding it from counterfeiting, piracy, and other forms of IP theft. According to industry estimates, IP theft costs the American economy billions of dollars and hundreds of thousands of jobs per year. The Organisation for Economic Co-operation and Development (OECD) estimated in 2007 that global cross-border trade in tangible, counterfeit and pirated products could have been as high as $250 billion. Since the OECD report does not take into account domestically produced and consumed products or non-tangible pirated digital products, the actual economic impact of counterfeiting and piracy is much more severe. These costs are expected to grow exponentially, if enforcement is not improved, as the United States continues its transition into a knowledge-based IP-reliant economy.

Given the importance of this ideas-based ecosystem, this study assesses the impact of innovation and the role of IP rights in 27 U.S. tradable industries between 2000 and 2007. We use industrial research and development (R&D) expenditures as a measure of the intensity of IP across industries since such expenditures are direct inputs for innovation and are the most widely used measures. We identify 15 IP-intensive industries–such as pharmaceuticals, aerospace, and petroleum–that have R&D expenditure per employee that exceed the national average. Similarly, we identify 12 non-IP-intensive industries–such as wood, textile, and paper–that spend less on R&D than the national average.

[1] This study covers 27 tradable manufacturing and non-manufacturing industries that the U.S. International Trade Commission reports export and import values during 2000-07.

Relative to non-IP-intensive tradable industries, U.S. IP-intensive tradable industries enjoy higher labor productivity, as measured by sales and value-added per employee. Consequently, they are more competitive in global markets as reflected in their higher exports. Since workers in IP-intensive industries are more productive by generating more output per person, IP-based firms pay higher salaries for both highly-skilled and low-skilled production jobs. With higher sales and higher wages, IP-intensive industries create highly-skilled jobs (including scientists, engineers, and above line-supervisor level) as well as low-skilled production jobs (up through line-supervisor level).

Innovation in IP-intensive industries also generates products and services and employment in non-IP-intensive industries. IP-intensive industries far outspend non-IP-based industries on research and development (R&D) and capital investments (such as buildings and equipment) per employee. IP-intensive industry investment in R&D and capital has a cascading effect on jobs and economic growth in their own, as well as in related industries. In every case, IP-intensive industries outperform non-IP-intensive industries in economic performance for job creation, wages, sales, value-added, exports, R&D expenditure, and capital spending.

Table 1. Economic Performance per Employee, 15 IP-Intensive versus 12 Non-IP-Intensive Industries, 2000–07

	Wages	Sales	Value-Added	Exports	R&D Spending	Capital Spending
IP-Intensive	$59,041	$485,678	$218,373	$91,607	$27,839	$15,078
Non-IP-Intensive	$37,202	$235,438	$115,239	$27,369	$2,164	$6,831
Difference	$21,839	$250,240	$103,134	$64,238	$25,676	$8,246
(times)	1.6	2.1	1.9	3.4	12.9	2.2

Key findings of the report are summarized in Table 1 and are as follows:

1. ***IP-intensive industries create jobs and spur economic growth resulting from high investments in research and development (R&D) in comparison to non-IP-intensive industries.*** While the direct outputs of R&D are typically the development of new forms of intellectual property, R&D spending also affects the economy by creating jobs and economic activities in R&D industries as well as in their supporting industries. During 2000-07, IP-intensive industries spent almost *13 times* the R&D per employee that non-IP-intensive industries spent—averaging $27,839 and $2,164 per employee per year, respectively.

2. ***IP-intensive industries sustain greater long-term economic growth.*** During 2000-07, workers in IP-intensive industries generated more than *two times* the output and sales per employee that workers in non-IP-based industries generated. Annual output (as measured by value-added) was $218,373 per employee in IP-intensive industries and only $115,239 in non-IP-intensive industries. During the same period, annual sales averaged $485,678

per employee in IP-intensive industries versus $235,438 in non-IP-intensive industries. This revenue is a contributing factor to economic growth and job expansion in other areas of the economy as well.

3. *IP-intensive industries promote exports and America's competitiveness abroad.* Investment in IP creates new products and services that strengthen America's competitiveness in global markets. IP-intensive industries, which made up nearly half of output and sales of all 27 U.S. tradable industries and employed more than *30 percent* of American workers in all 27 tradable industries, accounted for about *60 percent* of total U.S. exports. During 2000-07, the annual value of exports per employee in IP-intensive industries was 235 percent higher (3.4 times) than in non-IP-intensive industries, $91,607 and $27,369, respectively. Employment and economic activities to support exports in IP-intensive industries were also higher than in non-IP-intensive industries.

4. *IP-intensive industries generate trade surplus and therefore reduce U.S. trade deficits.* Of the 27 U.S. tradable industries, the collective trade deficit averaged nearly $540 billion per year during 2000-07; *more than half* of the deficit was attributable to non-IP-intensive industries. However, five of six industries that reported a trade surplus during 2000-07 were IP-intensive industries (basic chemicals; resin, synthetic rubber, fibers; navigational; aerospace; and, software). As a result, trade deficits during 2000-07 widened by only $112 billion in IP-intensive industries (55 percent from the 2000 level) compared to $150 billion in non-IP-intensive industries (76 percent from the 2000 level).

5. *IP-intensive industries create jobs during tough economic times and are better positioned to successfully emerge from economic downturns than non-IP industries.* During the 2000-07 business cycle, IP-intensive industries *created* 114,500 highly-skilled jobs for scientists and engineers (a 20.9 percent increase over the 2000 level) while non-IP-intensive industries cut 4,800 highly-skilled jobs for scientists and engineers (3 percent below the 2000 level). Since the economic downturns from 2004 and the aftermath of the dot-com bubble collapse, IP-intensive firms *gained* 8,019 low-skilled jobs (0.3 percent above the 2004 level), while non-IP-intensive industries continued cutting 76,194 low-skilled jobs (1.1 percent below the 2004 level).

6. *IP-intensive industries pay both highly-skilled and low-skilled employees more than non-IP-intensive industries.* IP-intensive companies have higher output and sale per employee and therefore pay their workers more than non-IP-intensive companies. During 2000-07, the annual salary of all workers in IP-intensive industries averaged about *60 percent higher* (1.6 times) than the workers at similar levels in non-IP-intensive industries ($59,041 versus $37,202 per employee per year, respectively). Low-skilled production workers (up through the line-supervisor level) account for 65 percent of total employment in all U.S. tradable industries. Annual salaries of low-skilled workers in IP-intensive industries averaged about *40 percent higher* than in non-IP-intensive industries ($43,478 and $31,345 per employee per year, respectively).

7. ***IP-intensive businesses are strong consumers for other IP-intensive and non-IP intensive industries.*** IP-intensive industries allocated over *2.2 times* (121 percent) the amount on capital expenditure per employee that non-IP-intensive industries allocated. During 2000-07, capital expenditure averaged $15,078 per employee in IP-intensive industries and $6,831 per employee in non-IP-intensive industries. Since capital acquired by firms includes such tradable products as machinery and equipment, and non-tradable items like buildings and other structures, IP-intensive industries also exert positive effects on supporting industries that add to job creation and economic growth.

Undoubtedly, intellectual property is an essential element enabling U.S. industries to grow and compete globally, which in turn creates jobs, improves the economy, and advances living standards. As a result of the critical importance of IP to American businesses, workers, and the economy, IP theft–whether by criminal organizations or countries that fail to honor their treaty obligations–is a growing concern for all. IP criminal and civil laws seem to be vague and less severe than traditional criminal statutes, arguably having less deterrent effect on persons and organizations engaged in these crimes. Meanwhile, the threats to IP have been growing exponentially and becoming more sophisticated, with the potential to reach $1 trillion globally over the next several years. The theft of patents, copyrights, trademarks and other forms of IP directly reduces sales and employment in IP-intensive companies and enterprises, hampering their productivity and growth. At the same time, some countries are undermining IP rights for their own competitive gain by failing to enforce current rules and norms. As such, efforts to ensure compliance with IP provisions in bilateral and regional free trade agreements and enforcing these obligations in multilateral fora are essential. The vulnerability of IP-intensive companies to theft also undermines the performance of non-IP-intensive industries.

In summary, our empirical findings reconfirm the literature and underscore the role of innovation and intellectual property in creating jobs, paying higher wages, driving exports, and sustaining economic growth. In all categories, IP-intensive industries outperform non-IP-intensive sectors, recovering more quickly during economic downturns and driving U.S. global competitiveness. As such, policymakers and government officials need to give higher priority to strengthening IP rights and laws internationally, while working to improve enforcement both at home and abroad. Such policies are urgently needed to ensure a more hospitable environment for innovation, which is so important for the future success of U.S. companies and industries, and for a more productive and rapidly expanding global economy.

I. INTRODUCTION

Economic theories of endogenous growth emphasize the critical importance of allocating resources to innovation in sustaining long-run economic growth in both developed and developing countries. Countries with the highest technological capacity are better able to enhance the efficiency of their production methods and exploit new market opportunities. These higher-technology-intensive countries enjoy more rapid economic growth because of the high returns to technology investment and the multiplier effects of technological spillovers to other economic sectors.[2] Studies also find the impact of innovation to be much greater for the aggregate economy than just for the manufacturing sector.[3]

Evidence suggests that roughly half of cross-country differences in per-capita income and growth are explained by differences in total factor productivity, which is driven mainly by technological progress.[4] Innovation is estimated to account for 80 percent of productivity growth in advanced countries; productivity growth, in turn, accounts for some 80 percent of GDP growth.[5]

In the global market, the United States has long maintained a competitive advantage in innovation and intellectual property, reflecting its substantial spending on research and development (R&D). The National Science Foundation (NSF) reports that U.S. industrial R&D spending by all sources totaled $368.1 billion in 2007, as large as the entire economy of such countries as Argentina, Denmark, Greece, and Taiwan. Industry spending on R&D in the United States accounts for approximately 72 percent of total spending, followed by universities and colleges (13.3 percent), the federal government (10.5 percent), and other nonprofit institutions (4.2 percent). During 1960-2007, when the U.S. economy grew at an average annual rate of 3.3 percent, R&D spending grew by an average 9 percent a year, registering only one year of negative growth (-4.1 percent in 2002) (Figure 1).

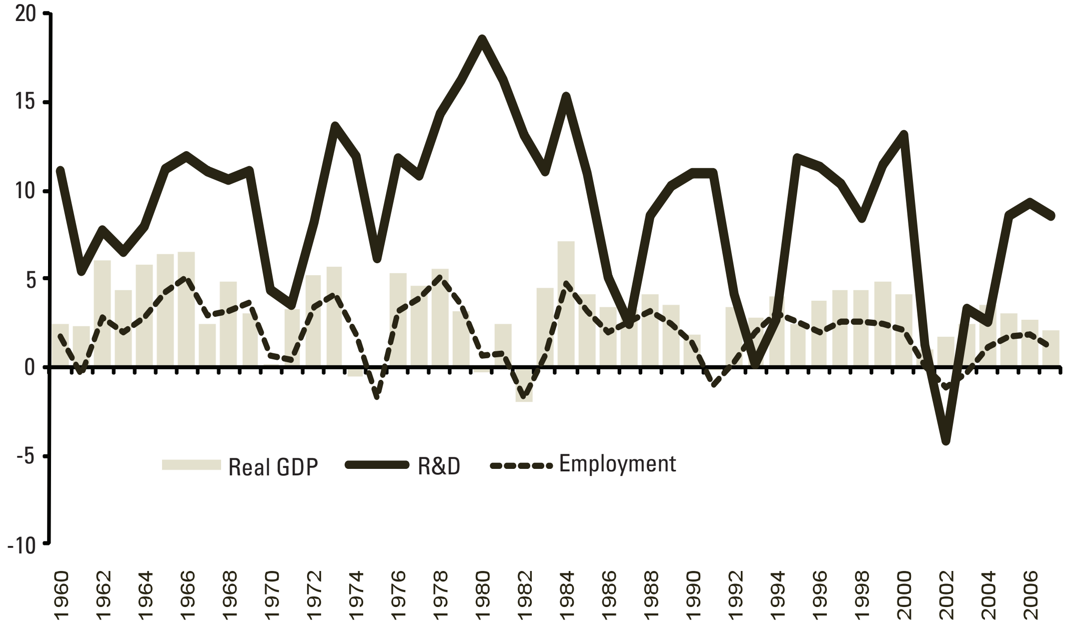
[2] Hall, Bronwyn H. and Adam B. Jaffe. 2001. "The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools" Tel Aviv University, The Foerder Institute for Economic Research.

[3] Ulku, Hulya. 2004. "R&D, Innovation, and Economic Growth: An Empirical Analysis." IMF Working Paper, International Monetary Fund.

[4] For example, Lederman, Daniel and William F. Maloney. 2003. "R&D and Development" Policy Research Working Paper, World Bank; Bresnahan, Timothy and Manuel Trajtenberg. 2001. "General Purpose Technologies 'Engines of Growth?'" NBER Working Papers No. 4148.

[5] Steinberg, Rolf and Olaf Arndt. 2001. "What Determines the Innovation Behavior of European Firms?" Economic Geography.

Figure 1. R&D, GDP, and Employment, Annual Growth Rates, 1960–2007[6]



The contribution of innovation to growth has re-emerged as a key theme in the global policy arena, even though the positive effects of innovation on both productivity and growth are well documented in the literature of past decades. Knowledge creation and the discovery of new technologies help explain the long-term U.S. technological growth trend, as well as periods of fast and slow productivity growth. Empirical economic studies, using different datasets for different time periods and different countries and regions, confirm that innovation is a critical contributor to sustainable economic growth. Technological innovation, which originates in R&D sectors using human capital and the existing knowledge stock, when applied to the production of final goods, leads to permanent gains in the output growth rate. Studies show that investing 2.3-2.6 percent of gross domestic expenditure on R&D would maximize the long-run impact on productivity growth and is the key to long-term productivity and technology gains.[7]

In the early-1970s, a series of studies examined the contribution of R&D to U.S. manufacturing output amid the productivity slowdown of those years. In his pioneering research on the economics of technological change, Mansfield (1972) found that R&D spending contributed substantially to the growth of output in many U.S. industries. Subsequent studies confirm Mansfield's main findings for U.S. industries, as well as for industries in other developed and developing countries.[8] Nadiri (1979), using U.S. manufacturing data for 1958-75, finds that the stock of R&D positively and strongly affects output growth in total manufacturing–total durable and non-durable industries. Nadiri also finds, as do other studies, that U.S. potential output growth in the 1970s was reduced by the R&D slowdown in the mid-1960s and early-1970s. The

[6] National Science Foundation, U.S. Bureau of Economic Analysis, and U.S. Bureau of Labor Statistics.

[7] Aw, Bee Yan, Mark J. Roberts and Daniel Yi Xu. 2009. "R&D Investment, Exporting and Productivity Dynamics." NBER Working Paper No. 14670.

[8] Mansfield, Edwin. 1972. "Contribution of Research and Development to Economic Growth of the United States." Papers and Proceedings of a Colloquium: Research and Development and Economic Growth Productivity, National Science Foundation.

growth rates of real public and private R&D spending in the United States dropped to 3 percent and 1.8 percent, respectively, during 1967-1975, compared with an average 14 percent and 7.1 percent, respectively, in the 1950s and early-1960s.[9]

Using cross-country and more recent data, studies have shown that innovation leads to permanent increases in economic growth and in GDP per-capita across countries. By using data for 20 OECD and 10 non-OECD countries for the period 1981-97, Ulku (2004) finds that innovation has a positive effect on output in both developed and developing countries. The R&D spending of large OECD countries spurred innovation in their own countries and their resulting knowledge additions also stimulated innovations in smaller OECD countries and developing countries. The study estimates that a 1 percent increase in innovation raises per-capita income by about 0.05 percent in both OECD and non-OECD countries, while a 1 percent rise in the R&D stock boosts innovation by about 0.2 percent in large OECD countries.[10] Other studies find strong evidence that R&D spillovers from industrial to developing countries have positive effects on factor productivity growth in developing countries.

When an innovation is introduced to the markets, technological spillovers benefit firms in regions with little or no R&D activity. Savvides and Zachariadis (2005) show that both domestic R&D and foreign direct investment accelerate domestic productivity and value added growth in developing countries.[11] But the technology and innovation is not fully mobile across countries. To benefit from the innovation spillovers, developing countries must possess the minimum required institutional and personnel capacity to apply the knowledge.[12]

Assessing innovation input and outcomes for firm-level data during 1998-2000, Griffith, Huergo, Mairesse, and Peters (2006) find a positive correlation between innovation and productivity–and a similar pattern across four large European countries (France, Germany, Spain, and the United Kingdom).[13] Loof and Heshmati used Swedish data in the 1990s on both manufacturing and service firms to measure the success of innovation through firms' output–such as value-added per employee, sales per employee, profit before and after depreciation, and sales margins. They find, as do other researchers, that the likelihood of firm innovation rises with its size and capital intensity in both manufacturing and services sectors. They estimate the elasticity of productivity with respect to the share of innovation sales at about 0.1; this means that when the share of innovation sales rises 10 percent, value-added rises 1 percent while sales and profits rise by about 2 percent. Using data for 3,000 Dutch firms, Van Leeuwen and Klomp find that innovation contributes positively to sales per employee, a measure of productivity. They also find that the return to innovation investment is sensitive to the technological environment in which firms operate.[14] Shapiro and Pham (2007) find

[9] Nadiri, M. Ishaq. 1979. "Contributions and Determinants of Research and Development Expenditures in the U.S. Manufacturing Industries." NBER Working Paper No. 360.

[10] Ulku, Hulya. 2004. "R&D, Innovation, and Economic Growth: An Empirical Analysis." IMF Working Paper, International Monetary Fund.

[11] Savvides, Andreas and Marios Zachariadis. 2005. "International Technology Diffusion and the Growth of TFP in the Manufacturing Sector of Developing Countries." The Review of Development Economics.

[12] Hall, Bronwyn H. and Adam B. Jaffe. 2001. "The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools." Tel Aviv University, The Foerder Institute for Economic Research.

[13] Griffith, Rachel, Elena Huergo, Jacques Mairesse, and Bettina Peters. 2006. "Innovation and Productivity Across Four European Countries." NBER Working Paper 12722.

that intellectual property contributed positive benefits--higher value-added per employee, higher wages, and higher employment--to IP-intensive manufacturing industries in the United States during 2000-04.[15]

The direct effect of innovation on economic growth is not only observed in Western economies. Jefferson and others (2006) use the most comprehensive panel data for 20,000 large- and medium-sized Chinese manufacturing companies to investigate the determinants of firm-level R&D intensity, the process of knowledge creation, and the impact of innovation with respect to firm performance on new product innovation, productivity, and profitability. As expected, the authors find that the roles of firm size, market concentration, and profitability in driving R&D parallel those in other countries. They find that new product innovation accounts for approximately 12 percent of the total returns to R&D. Furthermore, returns to industrial R&D in China appear to be at least three to four times the returns to fixed-production assets.[16]

The Effects on Trade

On the international trade front, economic theories have stressed the importance of hastening technological change in a country's production and exports. Investments in R&D and new technology both raise productivity and exports. Many studies investigate the potential role of firms' own investments in R&D as a component of the productivity-export link and find a positive linkage between innovation, productivity, and exports. Evidence from firm-level datasets shows that exports are positively correlated with R&D spending, which, in turn, affects productivity. Using data for the European Union countries, Criscuolo, Haskel, and Slaughter find that firms that operate globally devote more resources to assimilating knowledge from abroad and generate more innovations and productivity improvement.[17] Similarly, Griffith, Huergo, Mairesse, and Peters (2006) find that firms in France, Germany, Spain, and the United Kingdom that operate mainly in international markets are more likely to engage in R&D--and that this engagement is also more intensive.[18] Export structures in both developed and developing countries have implications for growth and development as well. Low-technology products tend to grow the slowest and technology-intensive products the fastest.[19]

Capital intensity is typically measured by the capital-labor ratio. Economic theories show that high capital-intensive countries enjoy higher standards of living, and vice versa. In addition, capital-

[14] Hall, Bronwyn H. and Jacques Mairesse. 2006. "Empirical Studies on Innovation in the Knowledge-Driven Economy." NBER Working Paper 12320.

[15] Shapiro, Robert J. and Nam D. Pham. (2007). "Economic Effects of Intellectual Property-Intensive Manufacturing in the United States." Sonecon.

[16] Jefferson, Gary H., Bai Huamao, Guan Xiaojing, and Yu Xiaoyun. 2006. "R&D Performance in Chinese Industry." Economics of Innovation and New Technology.

[17] Aw, Bee Yan, Mark J. Roberts, and Daniel Yi Xu. 2009. "R&D Investment, Exporting, and Productivity Dynamics." NBER Working Paper 14670.

[18] Griffith, Rachel, Elena Huergo, Jacques Mairesse and Bettina Peters. 2006. "Innovation and Productivity Across Four European Countries." NBER Working Paper 12722.

[19] Lall, Sanjaya. 2000. "The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-98." Oxford Development Studies, *Taylor and Francis Journals.*

abundant countries export capital-intensive products. Using firm-level data, studies show that the increase in the variance of capital/labor ratios across firms is related to the rising variance of wages.[20] Wages of high-tech-intensive industries are more than 50 percent higher than the median for all industries. Wages of technicians in high-tech industries, the lowest paid of the high-tech occupational categories, were also one-third higher than the median wage for all industries.[21]

II. MEASUREMENT OF INNOVATION AND DATA DESCRIPTION

Innovation measurement is a daunting task and remains in its infancy in both developed and developing countries. In 2007, the U.S. Department of Commerce created the Advisory Committee on Measuring Innovation in the 21st Century Economy. The Committee adopted the following definition of innovation:

> "The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm."[22]
>
> Intellectual property refers to creations of the mind that include inventions, literary, artistic works, symbols, names, images, and designs. Intellectual property is divided into two broad categories:
>
> (1) Industrial property that includes inventions, patents, trademarks, industrial designs, and geographic indications of source.
>
> (2) Copyright that includes both literary works such as novels, poems, plays, films, and music and artistic works such as drawings, paintings, photographs, sculptures, and architectural designs.[23]

Since the process of innovation involves different types of individuals–such as R&D experts, business and legal entities, suppliers and users—the effective use of IP tools becomes important in reducing risk and helping bring innovative technology to the market.

Several indicators are used to measure an enterprise's efforts to undertake R&D for the purposes of innovation. These data include R&D expenditure, information on innovation, and innovation strategies. These indicators are directly, or sometimes indirectly, influenced by IP.[24] Some data related to innovation are collected by government statistical agencies but the data are incomplete

[20] Leonardi, Marco. 2003. "Firms' Heterogeneity in Capital/Labor Ratios and Wage Inequality," Royal Economic Society Annual Conference 2003 136, Royal Economic Society.

[21] Tassey, Gregory. 2005 "R&D, Innovation and Economic Impact Indicators." National Institute of Standards and Technology.

[22] Department of Commerce. 2008 "Innovation Measurement: Tracing the State of Innovation in the American Economy." A report to the Secretary of Commerce by The Advisory Committee on Measuring Innovation in the 21st Century Economy.

[23] World Intellectual Property Organization. 2004. The WIPO Intellectual Property Handbook, WIPO.

[24] Kalanje, Christopher. 2006. "Role of Intellectual Property in Innovation and New Product Development." World Intellectual Property Organization.

and understate substantial sources of innovation in an economy. Some innovation data are tracked by private-sector organizations and firms but these data are also limited. Recently, government agencies, businesses, and trade associations have devoted more resources to developing such data. In the United States, the Census Bureau, on behalf of the National Science Foundation, conducts an annual firm-level survey of industrial R&D that gathers data on firms' R&D investments.

To estimate the economic impact of innovation on U.S. tradable industries, we use R&D expenditure as a measure for innovation. Studies show that R&D is a reliable indicator of innovative capacity and is one of six key factors determining the innovation success and financial performance of firms.[25] Boskin and Lau (1992) find R&D to be an important contributor to economic growth and a crucial factor in determining the competitiveness of firms in the marketplace, nationally and internationally.[26] Similarly, Mairesse and Mohnen (2004) find R&D to be positively correlated with all measures of innovation outputs. Innovation is generally more sensitive to R&D in low-tech than in high-tech sectors.[27] Evidence from patent literature also suggests that R&D spending directed at a product is the main input into the innovation production function and is proportional to the value of innovations in that product.[28]

Our Contributions

In this report, we examine data for the period 2000-07, which covers the full business cycle embracing the expansion during 2000-04 and the contraction in 2004-07. Our dataset includes the 27 subsectors (3-digit NAICS) and industries (4-digit NAICS) used by the U.S. International Trade Commission to report export values. We use industrial R&D spending and employed scientists and engineers (as published by the National Science Foundation) for 27 tradable subsectors and industries. The value of shipments (sales), value-added (outputs), employment, production workers up to line-supervisor level, wages, and capital expenditures come from the U.S. Census Bureau and the U.S. Bureau of Labor Statistics.

During 2000-07, industrial R&D spending by industry on 27 tradable industries totaled nearly $1.2 trillion, an average $145 billion annually. During the same period, employment in all tradable industries averaged 14.8 million workers. Average annual R&D spending per employee of 27 tradable industries was $9,956 during 2000-07. We identified 15 IP-intensive industries that have higher-than-average annual R&D expenditure per employee and 12 non-IP-intensive industries that have lower-than-average annual R&D expenditure per employee. The average annual R&D spending of these 15 IP-intensive industries was $27,839 per employee during 2000-07. For the other 12 non-IP-intensive industries, average annual R&D spending was only $2,164 per employee, almost 13 times less than IP-intensive industries (Table 2 and Figure 2).

[25] Steinberg, Rolf and Olaf Arndt. 2001. "What Determines the Innovation Behavior of European Firms?" Economic Geography.

[26] Boskin, Michael and Lawrence Lau. 1992. "Technology and the Wealth of Nations: Role of R&D and the Changing R&D Paradigm." Stanford University Press.

[27] Mairesse, Jacques and Pierre Mohnen. 2004. "The Importance of R&D for Innovation: A Reassessment Using French Survey Data." NBER Working Paper No. 10897.

[28] Wilson, Daniel J. 2001. "Is Embodied Technological Change the Result of Upstream R&D? Industry-Level Evidence." Federal Reserve Bank of San Francisco.

Table 2. Annual Average R&D Expenditure per Employee, by Industry, 2000–07[29]

	R&D ($ millions)	Employment (persons)	R&D per Employee ($)
All Tradable Industries	**$144,987**	**14,759,400**	**$9,956**
IP-Intensive	***$122,945***	***4,475,166***	***$27,839***
Petroleum, coal products	1,370	102,942	13,319
Chemicals	33,113	832,073	40,341
Basic chemicals	2,161	171,640	12,687
Resin, synthetic rubber, fibers	2,208	97,566	22,416
Pharmaceuticals, medicines	25,718	241,994	105,428
Computer, electronic products	42,043	1,238,549	34,978
Computers, peripheral equipment	4,834	144,205	38,552
Communications equipment	11,722	186,822	62,992
Semiconductor	15,556	435,562	37,980
Navigational, electro-medical	9,121	412,984	22,262
Transportation equipment	25,851	1,658,753	15,693
Motor vehicles, trailers	16,337	1,042,386	15,704
Aerospace products	8,384	403,496	21,162
Miscellaneous medical equipment	4,870	307,356	15,889
Information software	15,698	335,493	46,772
Non-IP-Intensive	***$22,042***	***10,284,229***	***$2,164***
Food, beverage, tobacco	2,519	1,625,869	1,551
Textiles, apparel, leather	480	789,043	702
Wood products	165	551,000	300
Paper, printing, support activities	2,630	1,182,400	2,238
Plastics, rubber products	1,884	934,068	2,027
Nonmetallic mineral products	804	485,865	1,652
Primary metals	612	493,207	1,273
Fabricated metal products	1,446	1,602,107	903
Machinery	7,488	1,183,201	6,411
Electrical equipment, appliances	2,728	477,381	5,663
Furniture	359	570,384	640
Misc non-medical equipment	928	389,705	2,415

[29] National Science Foundation and U.S. Bureau of Labor Statistics.

III. ECONOMIC IMPACT OF INNOVATION ON U.S. TRADABLE INDUSTRIES

We now examine the trend of U.S. industrial R&D expenditure, a widely used measure of innovation, and compare the economic performance of IP-intensive and non-IP-intensive industries during 2000-07. As intellectual property stimulates company R&D expenditures which create a catalyst for innovation, firms are expected to have higher sales and outputs and are expected to strengthen their competitiveness in global markets. Consequently, IP-intensive firms hire more employees and pay higher salaries. IP-intensive firms are also traditionally capital-intensive firms. Since capital acquired by firms includes tradable and non tradable products, innovation has indirect effects on other sectors in the economy.

Data for the United States during 2000-07 show that IP-intensive industries outperformed non-IP-intensive industries in all economic measures – sales, outputs, exports, wages, and capital expenditure. Figure 3 compares the economic performance per employee in 15 IP-intensive tradable industries and 12 non-IP-intensive tradable industries during 2000-07.

Figure 2. Annual Average R&D Expenditure per Employee, by Industry, 2000-07

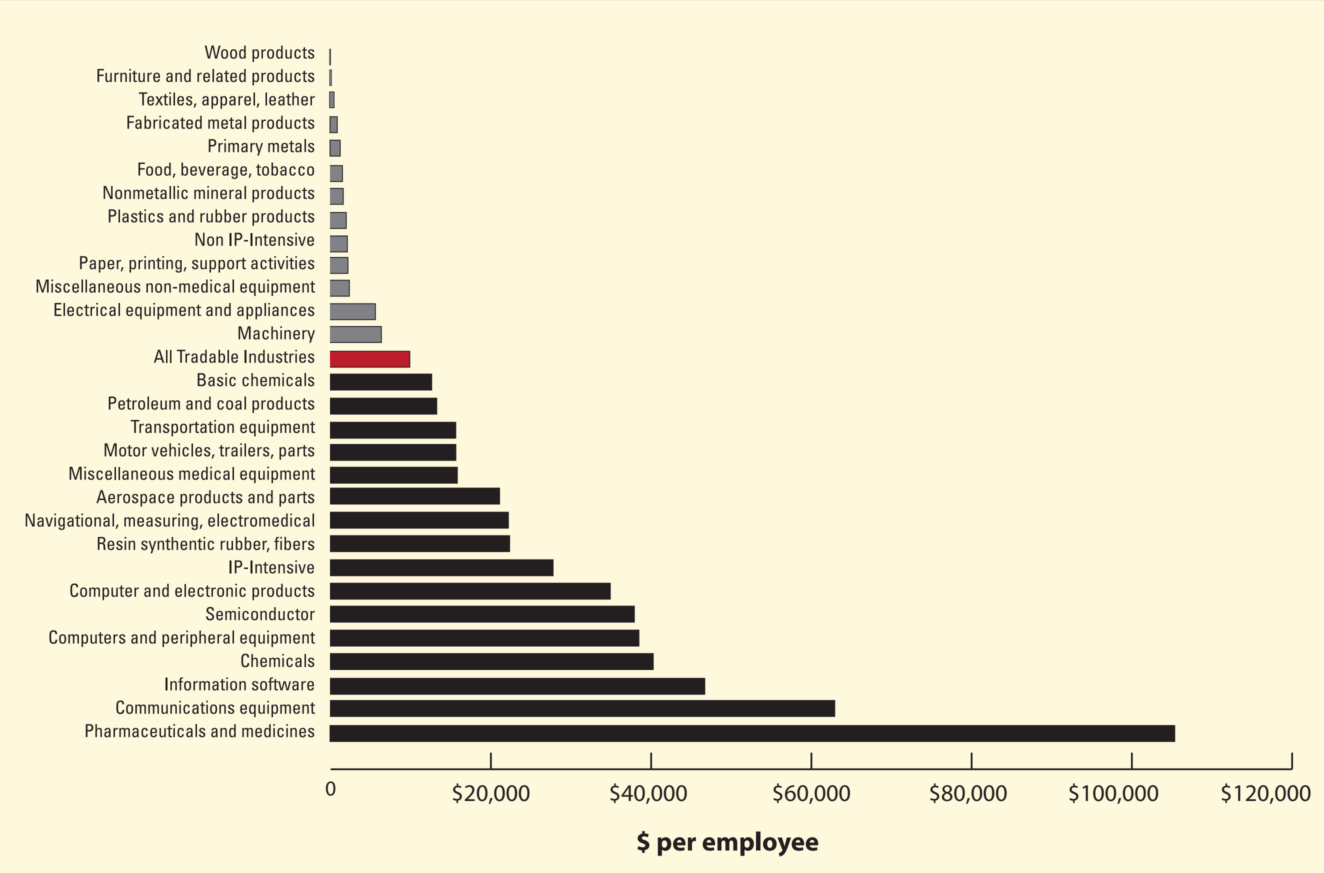
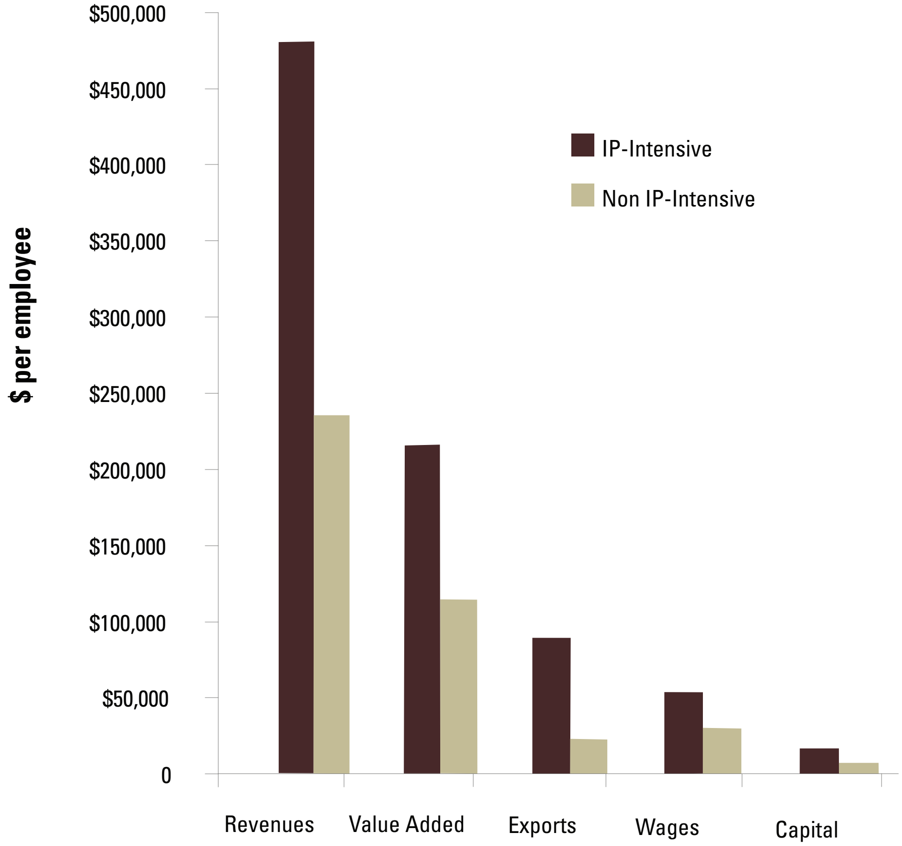


Figure 3. Economic Performance per Employee, IP-Intensive and Non-IP-Intensive Industries, 2000–07



R&D Spending in the United States during 2000–07

Research and development (R&D) expenditures are widely used to measure intellectual property since they are direct inputs for innovation. Industrial R&D spending of 27 tradable industries rose by more than 50 percent, an average of 5.9 percent a year, during 2000-07. Industrial R&D spending grew much more rapidly in years of economic contraction than expansion. During the expansion years of 2000-04, R&D spending grew an average 4.2 percent annually, while spending increased 8.4 percent during 2004-07 when the U.S. economy was contracting.

R&D expenditure in 15 IP-intensive industries rose at an average 6.3 percent a year during 2000-07, versus 4 percent in 12 non-IP-intensive industries. During 2000-07, R&D spending of pharmaceuticals and aerospace industries (two industries with the fastest growth in R&D spending) increased an average 20.7 percent a year and 19.3 percent a year, respectively. Although the textile industry is one of the lowest R&D-intensive industries (accounting for just 0.3 percent of total U.S. industrial R&D), it recorded an average annual R&D expenditure growth of 17 percent during 2000-07 (Table 3).

Table 3. Annual Average R&D Expenditure and Growth Rates, by Industry, 2000–07 [30]

	R&D Average 2000–07 ($ millions)	Average Annual Growth		
		2000-07 (%)	2000-04 (%)	2004-07 (%)
All Tradable Industries	**$144,987**	**6.0%**	**4.2%**	**8.4%**
IP-Intensive	***$122,945***	***6.3%***	***4.7%***	***8.5%***
Petroleum, coal products	1,370	5.6	8.0	2.5
Chemicals	33,113	15.0	17.1	12.3
Basic chemicals	2,161	6.4	3.1	11.0
Resin, synthetic rubber, fibers	2,208	-14.5	-7.5	-23.0
Pharmaceuticals, medicines	25,718	20.7	25.2	14.8
Computer, electronic products	42,043	1.6	-2.2	6.9
Computers, peripheral equipment	4,834	4.2	2.5	6.4
Communications equipment	11,722	-4.8	-15.0	10.7
Semiconductor	15,556	5.3	8.2	1.5
Navigational, electro-medical	9,121	2.8	-6.0	15.9
Transportation equipment	25,851	4.4	3.2	6.0
Motor vehicles, trailers	16,337	-1.9	-3.9	0.9
Aerospace products	8,384	19.3	24.1	13.2
Miscellaneous medical equipment	4,870	4.6	-3.0	15.6
Information software	15,698	6.6	7.1	5.9
Non-IP-Intensive	***$22,042***	***4.0%***	***1.4%***	***7.6%***
Food, beverage, tobacco	2,519	9.5	15.8	1.6
Textiles, apparel, leather	480	17.0	20.9	11.9
Wood products	165	9.8	9.7	9.9
Paper, printing, support activities	2,630	-0.6	-3.8	4.0
Plastics, rubber products	1,884	3.1	2.9	3.3
Nonmetallic mineral products	804	4.0	-1.9	12.4
Primary metals	612	5.8	4.2	7.9
Fabricated metal products	1,446	-0.3	-2.6	2.9
Machinery	7,488	5.9	-0.3	14.8
Electrical equipment, appliances	2,728	-3.6	-6.2	-0.1
Furniture	359	10.8	9.3	12.7
Misc non-medical equipment	928	15.3	22.9	5.9

During 2000-07, industrial R&D spending per employee in all tradable industries averaged $9,956 a year. Industrial R&D expenditure of all tradable industries grew by an average 9.2 percent a year. Additionally, industrial R&D spending grew 8.8 percent annually during 2000-04 when the economy was on an upswing and 9.6 percent during 2004-07 when the economy was in a downswing.

[30] National Science Foundation.

Table 4. Annual Average R&D Expenditure per Employee and Growth Rates, by Industry, 2000–07[31]

	R&D Average 2000-07 ($)	Average Annual Growth Rates		
		2000-07 (%)	2000-04 (%)	2004-07 (%)
All Tradable Industries	**$9,956**	**9.2%**	**8.8%**	**9.6%**
IP-Intensive	***$27,839***	***9.3%***	***9.1%***	***9.5%***
Petroleum, coal products	13,319	6.4%	9.4%	2.6%
Chemicals	40,341	16.8%	19.3%	13.7%
Basic chemicals	12,687	8.7%	7.0%	11.0%
Resin, synthetic rubber, fibers	22,416	-11.4%	-3.0%	-21.4%
Pharmaceuticals, medicines	105,428	19.6%	22.7%	15.6%
Computer, electronic products	34,978	7.6%	6.4%	9.1%
Computers, peripheral equipment	38,552	14.6%	14.2%	15.2%
Communications equipment	62,992	2.6%	-3.0%	10.5%
Semiconductor	37,980	12.3%	20.3%	2.5%
Navigational, electro-medical	22,262	5.5%	-2.7%	17.5%
Transportation equipment	15,693	7.0%	6.9%	7.1%
Motor vehicles, trailers	15,704	1.6%	-0.7%	4.6%
Aerospace products	21,162	20.8%	29.8%	9.9%
Miscellaneous medical equipment	15,889	4.0%	-3.3%	14.6%
Information software	46,772	0.0%	0.0%	0.0%
Non-IP-Intensive	***$2,164***	***7.2%***	***6.0%***	***9.0%***
Food, beverage, tobacco	1,551	9.9%	15.8%	2.5%
Textiles, apparel, leather	702	29.6%	35.5%	22.3%
Wood products	300	11.8%	12.8%	10.4%
Paper, printing, support activities	2,238	3.2%	0.7%	6.6%
Plastics, rubber products	2,027	6.2%	6.9%	5.4%
Nonmetallic mineral products	1,652	5.6%	0.7%	12.4%
Primary metals	1,273	10.7%	12.0%	8.9%
Fabricated metal products	903	1.6%	1.5%	1.7%
Machinery	6,411	8.9%	5.8%	13.1%
Electrical equipment, appliances	5,663	1.6%	0.9%	2.6%
Furniture	640	14.2%	13.3%	15.4%
Misc non-medical equipment	2,415	18.0%	25.4%	8.7%

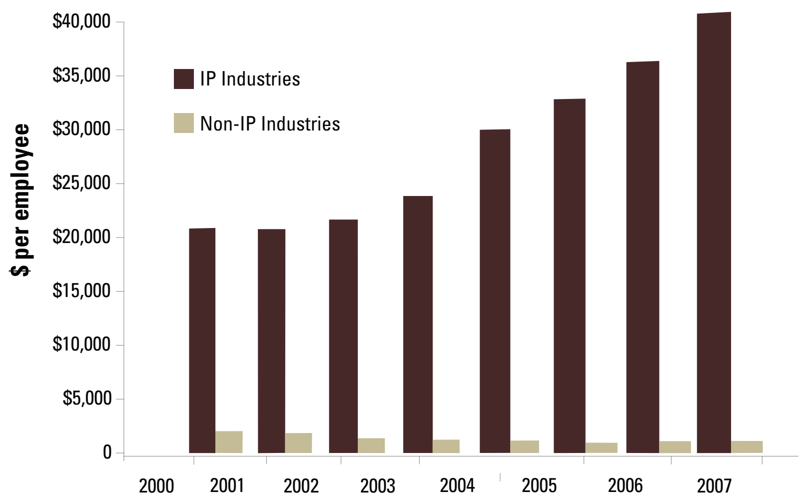
Among 27 tradable industries, 15 IP-intensive industries had higher-than-average and 12 non-IP-intensive industries had lower-than-average R&D spending per employee. During 2000-07, R&D spending in IP-intensive industries was $27,839 per employee and grew by an average 9.3 percent a year. In contrast, R&D spending in non-IP-intensive industries was only $2,164 per

[31] National Science Foundation.

employee and was growing at 7.2 percent a year. R&D spending per employee in both IP-intensive and non-IP-intensive industries grew faster during the business-cycle downswing in 2004-07 than in the upswing in 2000-04 (Table 4).

During 2000-07, R&D spending per employee in 15 IP-intensive industries was higher and grew faster than R&D spending in 12 non-IP-intensive industries. In 2000, R&D expenditure was $20,883 per employee in IP-intensive industries, more than 11 times that in non-IP-intensive industries. During 2000-07, R&D expenditure per employee grew by more than 86 percent in IP-intensive industries relative to 63 percent in non-IP-intensive industries. In 2007, annual R&D spending was $38,897 per employee in IP-intensive industries, almost 13 times the annual spending in non-IP-intensive industries (Figure 4).

Figure 4. Annual R&D Expenditure per Employee in IP- and Non-IP-Intensive Industries, 2000-07[32]



Labor Productivity

Labor productivity measures the value of goods and services produced per unit of labor and capital. Productivity growth facilitates the ability to create higher-value products and services, as well as improve the efficiency of production. Empirically, productivity is often measured by the value of shipments (sales) and value-added (outputs) per employee. The value of shipments represents total sales earned by business enterprises. Value-added is derived by subtracting the cost of materials, supplies, fuel, and contract work from the value of shipments. Since value-

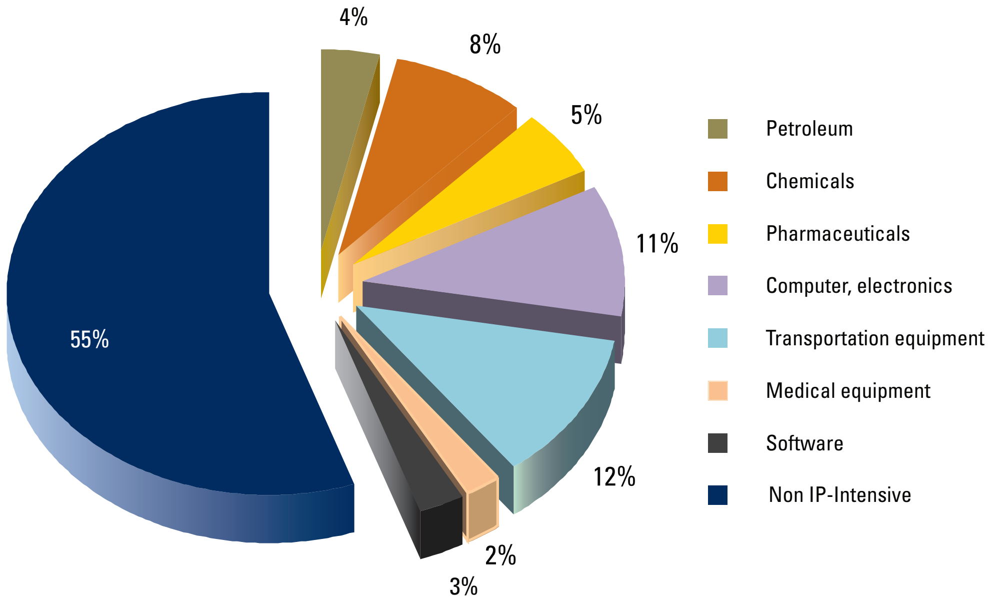
[32] National Science Foundation and U.S. Census Bureau.

[33] U.S. Census Bureau.

added is the difference between the sales value and the cost of merchandise sold without further manufacturing, value added avoids the double counting of intermediate products.[33]

Value-Added (Outputs). Intellectual property includes tangible and intangible assets that belong to a company. Therefore, IP has a direct impact on the company's outputs and sales. During 2000-07, the annual value-added--the preferred measure for comparing economic performance among industries and geographic areas--of the 27 tradable industries averaged $2.131trillion. Value-added of 15 tradable IP-intensive industries averaged $956 billion a year during 2000-07, which accounted for approximately 45 percent of total value added of the 27 tradable industries. More than 80 percent of value-added in IP-intensive industries came from chemicals (including pharmaceuticals), transportation equipment, and computer and electronic product industries (Figure 5).

Figure 5. Composition of Value-Added, by Industry, Average 2000-07[34]



The annual value-added of all 15 IP-intensive industries was $218,373 per employee during 2000-07. The value-added per employee of IP-intensive industries was more than 50 percent higher than the national average and almost twice the average of non-IP-intensive industries. The three industries with the highest value-added per employee were all IP-intensive: petroleum ($743,147), pharmaceuticals ($471,853), and basic chemicals ($358,769) (Table 5).

[34] U.S. Census Bureau.

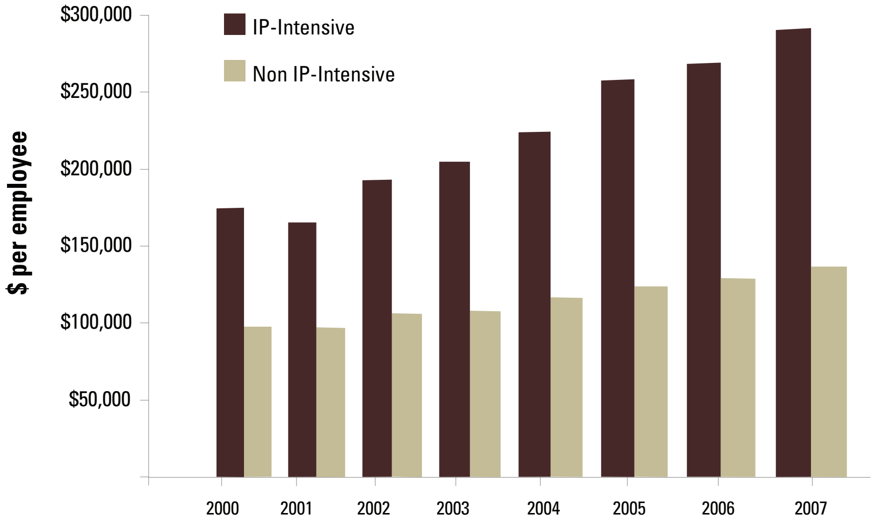
[35] National Science Foundation, U.S. Census Bureau, and U.S. Bureau of Labor Statistics; value added of information software reflect two years: 2002 and 2006.

Table 5. Annual Average Value-Added and Share of R&D, by Industry, 2000–07[35]

	Value-Added ($ millions)	Value-Added per Employee ($)	R&D as % of Value-Added (%)
All Tradable Industries	**$2,131,428**	**$144,832**	**6.2%**
IP-Intensive	***$955,978***	***$218,373***	***11.9%***
Petroleum, coal products	76,426	743,147	2.1
Chemicals	290,134	351,085	11.0
Basic chemicals	60,587	358,769	3.7
Resin, synthetic rubber, fibers	27,984	292,071	8.3
Pharmaceuticals, medicines	114,564	471,853	21.3
Computer, electronic products	227,014	187,231	18.5
Computers, peripheral equipment	34,636	255,949	14.0
Communications equipment	39,063	210,906	30.0
Semiconductor	78,792	186,611	20.0
Navigational, electro-medical	67,248	164,556	13.6
Transportation equipment	252,757	153,262	10.2
Motor vehicles, trailers	159,036	153,465	10.3
Aerospace products	70,324	174,856	11.7
Miscellaneous medical equipment	47,094	152,974	10.6
Information software	62,554	190,754	25.4
Non-IP-Intensive	***$1,175,319***	***$115,239***	***1.9%***
Food, beverage, tobacco	291,180	179,189	0.9
Textiles, apparel, leather	54,635	71,303	0.9
Wood products	39,428	71,699	0.4
Paper, printing, support activities	136,398	116,289	1.9
Plastics, rubber products	93,914	101,153	2.0
Nonmetallic mineral products	60,928	125,940	1.3
Primary metals	68,286	142,133	0.9
Fabricated metal products	152,479	95,681	1.0
Machinery	141,311	120,333	5.3
Electrical equipment, appliances	56,282	119,882	4.8
Furniture	43,752	77,269	0.8
Misc non-medical equipment	36,728	94,834	2.5

R&D as a percent of value-added averaged 6.2 percent in all 27 industries during 2000-07. The average ratio of IP-intensive industries was 11.9 percent, versus just 1.9 percent in non-IP-intensive industries. The three industries with the highest R&D (as a percent of value-added) were all IP-intensive industries: communication equipment, software information, and pharmaceuticals (Table 5).

Figure 6. Annual Value-Added per Employee in IP- and Non-IP-Intensive Industries, 2000–07[36]



The value-added per employee differential between IP-intensive and non-IP-intensive widened over the past decade, reflecting the higher productivity of IP-intensive employees. Value-added was $165,533 per employee in IP-intensive industries in 2001, versus just $96,989 in non-IP-intensive industries. The value-added differential was $68,444 per employee, the equivalent of about 71 percent of value-added per employee in non-IP-intensive industries. Value-added in IP-intensive industries grew by almost 68 percent, to $277,806 per employee in 2007, compared with 42 percent growth in non-IP-intensive industries. The value-added differential thus widened from $68,444 per employee in 2001 to $139,983 in 2007, more than double the $137,913 value-added per employee in non IP-intensive industries in 2007 (Figure 6).

Sales (Revenues). Total sales (revenues or shipment values) include the received or receivable net selling values (excluding freight and taxes) of all three components: the primary product value of shipments, secondary product value of shipments, and miscellaneous receipts. The value of shipments includes all items made by or for the establishments from material owned by it, whether sold, transferred to other plants of the same company, or shipped on consignment.[37]

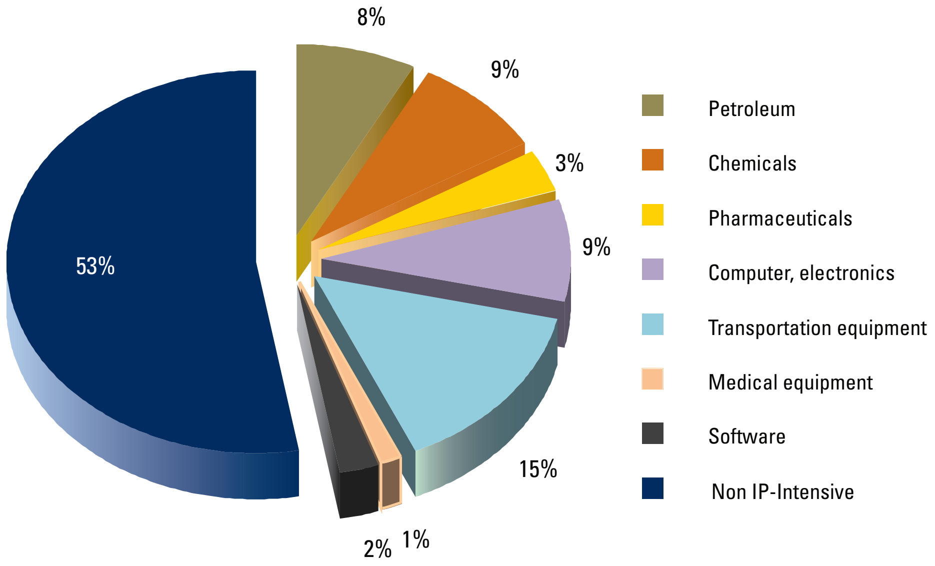
Total sales of 27 tradable industries to the U.S. economy averaged $4.55 trillion per year during 2000-07, rising from $4.3 trillion in 2000 to $5.4 trillion in 2007. IP-intensive industries accounted

[36] National Science Foundation and U.S. Census Bureau.

[37] U.S. Census Bureau.

[38] U.S. Census Bureau.

Figure 7. Composition of Revenues, by Industry, Average 2000–07[38]



for more than 47 percent, contributed by transportation equipment (15 percent), chemicals (9 percent), computer and electronics (9 percent), petroleum and coal (8 percent), pharmaceuticals (3 percent), software information (2 percent), and medical equipment (1 percent). The composition of sales by industry differs slightly from the composition of value-added by industry, reflecting different immediate cost structures among industries. Petroleum, chemical, and transport equipment industries have smaller shares of value added than their shares of revenues. In contrast, pharmaceuticals, computer, medical equipment, and software information all have larger shares of value added than their shares of revenues (Figure 7).

Average revenue per employee in 15 IP-intensive industries is twice as high as in 12 non-IP-intensive industries. Revenue per-employee averaged $311,348 in all 27 tradable industries; revenue in the 15 IP-intensive industries averaged $485,678 versus $235,438 in 12 non-IP-intensive industries (Table 6).

R&D spending as a percent of revenues in 15 IP-intensive industries was higher and grew faster than in 12 non-IP-intensive industries. R&D expenditure as a percent of revenues of all 27 tradable industries rose from less than 3 percent in the early 2000s to more than 3.5 percent in 2007. While the share of R&D to revenues in non-IP-intensive industries remained unchanged at 0.9-1.0 percent over the last decade, the share of R&D to revenues in IP-intensive industries rose from 5.3 percent in 2000 to more than 6.1 percent in 2007, and to an average of 5.7 percent during 2000-07 (Table 6).

Table 6. Annual Average Sales per Employee and Shares of R&D, by Industry, 2000–07[39]

	Sales ($ millions)	Sales per Employee ($)	R&D as % of Sales (%)
All Tradable Industries	**$4,549,582**	**$311,348**	**3.2%**
IP-Intensive	***$2,149,999***	***$485,678***	***5.7%***
Petroleum, coal products	359,485	3,494,274	0.4
Chemicals	546,143	660,902	5.8
Basic chemicals	148,843	880,049	1.5
Resin, synthetic rubber, fibers	76,945	805,409	3.1
Pharmaceuticals, medicines	154,907	638,540	15.8
Computer, electronic products	396,795	324,865	10.6
Computers, peripheral equipment	75,343	539,376	6.8
Communications equipment	75,217	404,332	15.6
Semiconductor	123,713	291,202	12.8
Navigational, electro-medical	105,912	258,939	8.6
Transportation equipment	665,120	402,934	3.9
Motor vehicles, trailers	481,864	465,010	3.4
Aerospace products	134,916	335,266	6.1
Miscellaneous medical equipment	66,786	216,977	7.4
Information software	115,670	344,749	13.5
Non-IP-Intensive	***$2,399,940***	***$235,438***	***0.9%***
Food, beverage, tobacco	617,069	379,792	0.4
Textiles, apparel, leather	121,449	157,373	0.4
Wood products	99,080	180,037	0.2
Paper, printing, support activities	259,405	221,198	1.0
Plastics, rubber products	188,725	203,564	1.0
Nonmetallic mineral products	106,929	220,994	0.7
Primary metals	181,206	378,768	0.3
Fabricated metal products	278,302	174,646	0.5
Machinery	290,017	247,208	2.6
Electrical equipment, appliances	113,499	242,168	2.4
Furniture	78,930	139,437	0.5
Misc non-medical equipment	65,327	168,545	1.4

The IP-intensive pharmaceuticals and communications industries spent more than 15 percent of revenues on R&D. Although the petroleum and coal industry is IP-intensive and spent an annual average $13,319 on R&D per employee, its R&D spending as a percent of revenues is low, owing

[39] National Science Foundation, U.S. Census Bureau, and U.S. Bureau of Labor Statistics.

to its extraordinarily high revenues (more than 8 percent of the total shipment value of all tradable industries during 2000-07 and more than 11 percent in 2007). Other non-IP-intensive industries, such as wood products and textiles, spent about 0.2-0.4 percent of their annual revenues on R&D (Table 6).

Table 7. Annual Average Exports and Shares of R&D Expenditure, by Industry, 2000–07[40]

	Exports ($ millions)	Exports per Employee ($)	Exports as % of Revenues (%)	R&D as % of Exports (%)
All Tradable Industries	***$683,647***	***$46,861***	***14.9%***	***18.9%***
IP-Intensive	$405,515	$91,607	18.8%	26.4%
Petroleum, coal products	15,185	147,524	4.0	10.9
Chemicals	102,136	123,815	18.5	31.2
Basic chemicals	35,351	208,789	24.0	6.3
Resin, synthetic rubber, fibers	20,949	220,598	26.9	11.8
Pharmaceuticals, medicines	25,007	102,843	15.8	96.3
Computer, electronic products	130,735	107,601	33.0	32.2
Computers, peripheral equipment	31,641	228,998	42.2	15.8
Communications equipment	14,736	82,664	20.3	79.3
Semiconductor	49,722	117,193	40.3	31.8
Navigational, electro-medical	29,465	72,098	27.8	31.0
Transportation equipment	143,508	87,209	21.4	18.3
Motor vehicles, trailers	75,662	73,435	15.7	22.1
Aerospace products	62,633	155,858	45.9	13.1
Miscellaneous medical equipment	13,374	43,369	19.8	38.5
Information software	577	1,719	0.5	3000.8
Non-IP-Intensive	***$278,132***	***$27,369***	***11.5%***	***8.0%***
Food, beverage, tobacco	32,664	20,113	5.3	7.7
Textiles, apparel, leather	17,311	22,974	14.5	2.8
Wood products	4,368	7,924	4.4	3.8
Paper, printing, support activities	21,003	18,022	8.1	12.7
Plastics, rubber products	17,831	19,260	9.4	10.7
Nonmetallic mineral products	7,143	14,703	6.7	11.1
Primary metals	25,214	53,087	13.5	2.6
Fabricated metal products	22,485	14,116	8.0	6.6
Machinery	89,345	76,393	30.5	8.4
Electrical equipment, appliances	25,540	55,180	22.4	11.0
Furniture	2,739	4,846	3.5	13.0
Misc non-medical equipment	12,492	32,493	18.9	7.8

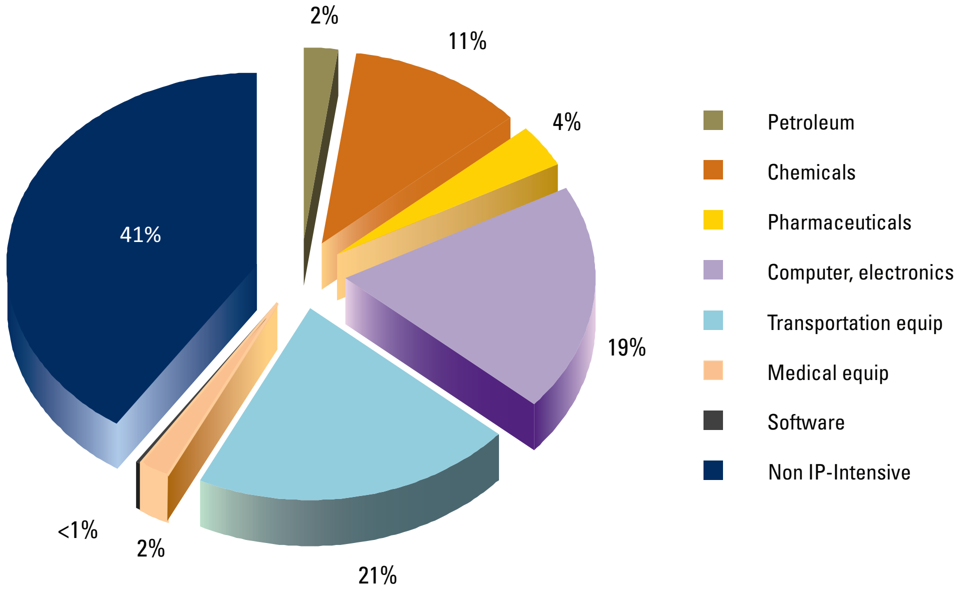
[40] National Science Foundation, U.S. Census Bureau, and U.S. International Trade Commission.

Exports and Trade Balances

With only limited exceptions, U.S. IP-intensive industries are large exporters to international markets. The U.S. International Trade Commission reports that American companies exported an average of 15 percent of their total sales (value of shipments) during 2000-07. Total exports of the 27 tradable industries rose from $665 billion in 2000 to $910 billion in 2007, a 41.2 percent increase and an average gain of 5 percent a year. During 2000-07, American firms exported an annual average $405.5 billion of IP-intensive products, versus $278.1 billion of non-IP-intensive products (Table 7).

IP-intensive industries accounted for nearly 60 percent of total U.S. exports during 2000-07. The U.S. ITC data show that transportation equipment, an IP-intensive industry, was the largest export industry, accounting for 21 percent of total U.S. exports during 2000-07. Another two IP-intensive industries – the computer and electronics and chemical industries–contributed 19 percent and 11 percent, respectively, to total U.S. exports (Figure 8).

Figure 8. Composition of U.S. Exports by Industry, Average 2000–07[41]



IP-intensive industry exports helped moderate U.S. trade deficits during 2000-07. Each year, the U.S. exported an average of $683.7 billion of products in 27 tradable industries and imported approximately $1.2 trillion. Thus, U.S. trade deficits of 27 industries averaged nearly $540 billion a year. Among 27 tradable industries, only six industries reported trade surpluses during 2000-07. Five of these six industries are IP-intensive industries (basic chemicals; resin, synthetic rubber, fibers; navigational; aerospace; and, software). During this period, these five IP-intensive industries generated an average $14.6 billion trade surplus a year. As a result, more than half of

[41] U.S. International Trade Commission.

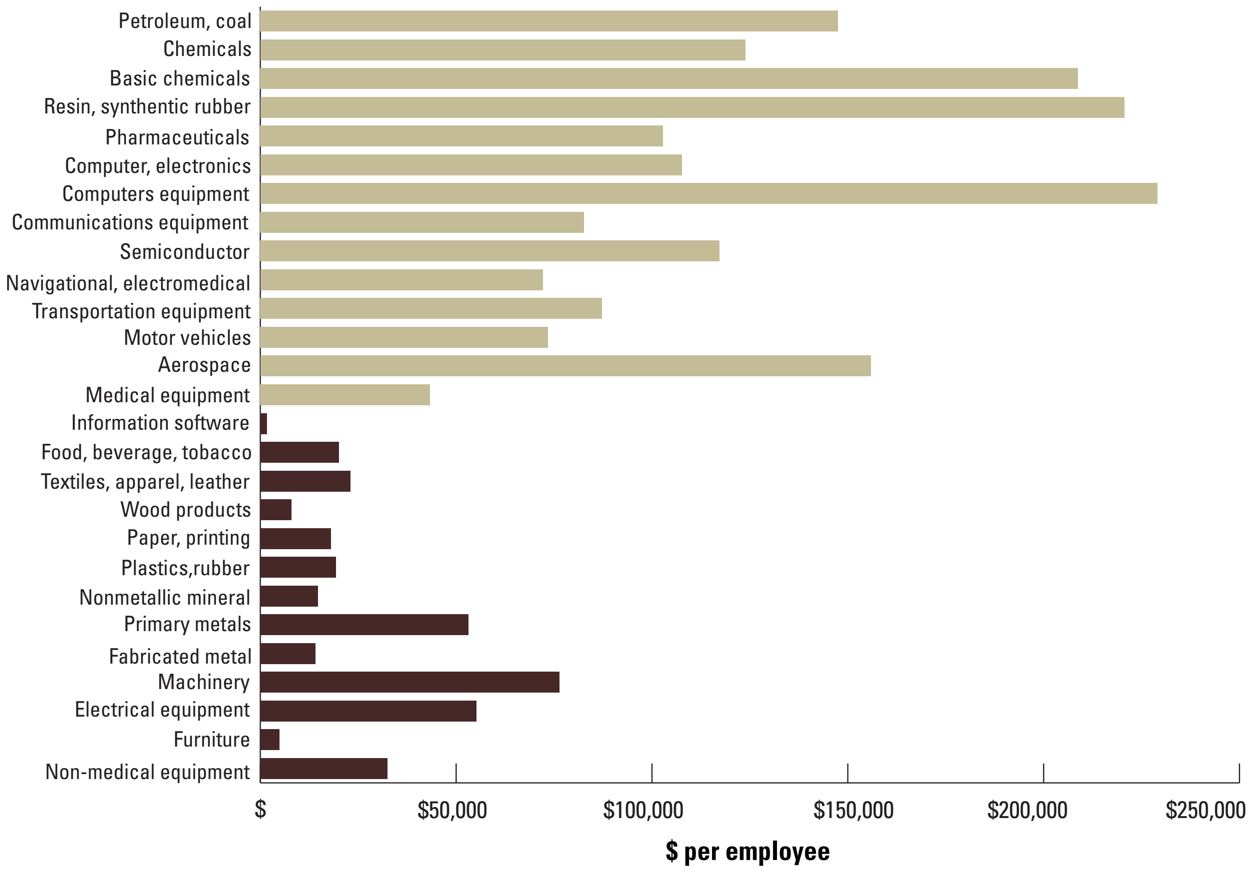
[42] National Science Foundation, U.S. Census Bureau, and U.S. International Trade Commission.

Table 8. Annual Average Exports, Imports and Trade Balance, by Industry, 2000–07[42]

	Exports ($ millions)	Imports ($ millions)	Trade Balance ($ millions)
All Tradable Industries	**$683,647**	**$1,222,595**	**-$538,947**
IP-Intensive	***$405,515***	***$665,481***	***-$259,966***
Petroleum, coal products	15,185	45,755	-30,570
Chemicals	102,136	109,023	-6,887
Basic chemicals	35,351	31,066	4,285
Resin, synthetic rubber, fibers	20,949	11,589	9,359
Pharmaceuticals, medicines	25,007	50,422	-25,415
Computer, electronic products	130,735	254,710	-123,976
Computers, peripheral equipment	31,641	73,618	-41,977
Communications equipment	14,736	40,576	-25,839
Semiconductor	49,722	70,597	-20,875
Navigational, electro-medical	29,465	28,961	504
Transportation equipment	143,508	241,810	-98,302
Motor vehicles, trailers	75,662	205,950	-130,289
Aerospace products	62,633	28,011	34,622
Miscellaneous medical equipment	13,374	14,059	-685
Information software	577	123	455
Non-IP-Intensive	***$278,132***	***$557,114***	***-$278,982***
Food, beverage, tobacco	32,664	20,142	12,521
Textiles, apparel, leather	17,311	118,167	-100,856
Wood products	4,368	20,176	-15,808
Paper, printing, support activities	21,003	26,857	-5,854
Plastics, rubber products	17,831	25,256	-7,425
Nonmetallic mineral products	7,143	18,449	-11,306
Primary metals	25,214	58,077	-32,863
Fabricated metal products	22,485	37,463	-14,978
Machinery	89,345	96,582	-7,236
Electrical equipment, appliances	25,540	51,630	-26,090
Furniture	2,739	23,776	-21,037
Misc non-medical equipment	12,492	60,539	-48,047

[43] U.S. International Trade Commission and U.S. Bureau of Labor Statistics.

Figure 9. Annual Average Exports per Employee, by Industry, 2000–07[43]

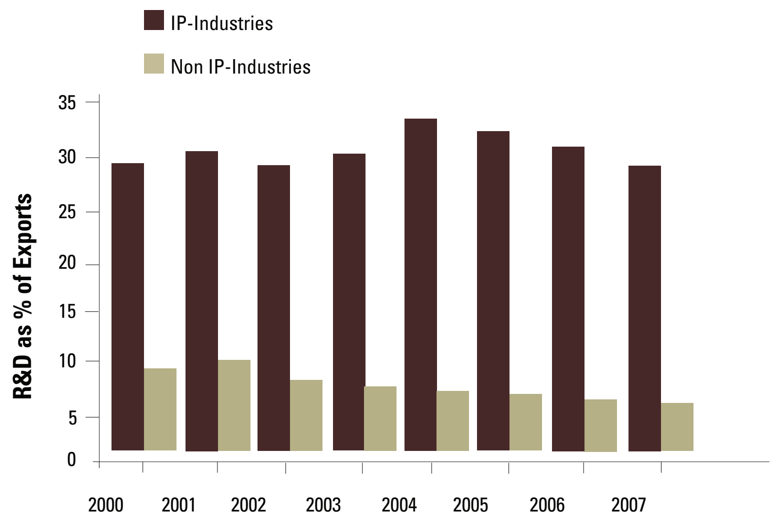


U.S. trade deficits were accounted for by non-IP-intensive industries. Furthermore, imports of IP-intensive industries grew more slowly than non-IP-intensive industries, 46.1 percent and 56.2 percent, respectively. Consequently, annual trade deficits during 2000-07 widened by only $112 billion in IP-intensive industries (55 percent relative to the 2000 level) versus $150 billion in non-IP-intensive industries (76 percent relative to 2000) (Table 8).

Exports of all 27 tradable industries averaged $46,861 per employee during 2000-07, but average exports per employee of IP-intensive industries was $91,607, more than three times the average for non-IP-intensive industries. The three industries with the highest exports per employee were all IP-intensive: computer and peripheral equipment; resin, synthetic rubber, fibers and filament; and basic chemicals. Except for the software information industry, exports per employee of every IP-intensive industry exceeded the national average (Figure 9).

R&D spending as a percent of total exports averaged 21.2 percent during 2000-07. R&D expenditure of IP-intensive industries averaged 30.2 percent of their export value during this period, peaking at 33.2 percent in 2004. In contrast, R&D expenditure of non-IP-intensive industries accounted for only 8 percent of their exports. R&D spending as a percent of exports of non-IP-intensive industries, however, continued declining–from 9.1 percent in 2001 to 7 percent in 2007 (Figure 10).

Figure 10. R&D Expenditure as % of Exports, IP- and Non-IP-Intensive Industries, 2000–07[44]



In its *Exports from Manufacturing Establishments*, the Census Bureau includes estimates for the value of manufactured exports and related employment, including both "direct" and "supporting" exports. Direct exports are goods manufactured in the U.S. and consumed in foreign markets. Supporting export shipments are intermediate goods and services required to manufacture the exported goods.[45]

As shown earlier, IP-intensive industries exported more direct goods than non-IP-intensive industries. Furthermore, IP-intensive industries consumed more supporting goods and services and employed more supporting jobs in both manufacturing and non-manufacturing industries. Data for four years from the U.S. Census (2002-06) show direct exports accounted for 13 percent of total manufacturing shipments and employed 12.3 percent of all manufacturing workers. In the same period, IP-intensive manufacturing industries exported 17.1 percent of total manufacturing shipments while non-IP-intensive industries exported only 9.4 percent. IP-intensive manufacturing industries employed 21 percent of all workers to produce direct exports; in contrast, only 9 percent of workers in non-IP-intensive manufacturing industries produced direct exports. Supporting shipments and employment for exports in IP-intensive industries were slightly higher than in non-IP-intensive industries. During 2002-06, supporting employment for exports as a percent of total employment in IP-intensive industries was 6.6 percent, compared with 5.7 percent in non-IP-intensive industries. Similarly, supporting shipments for exports as a percent of all shipments in IP-intensive industries was 5.4 percent, much the same as the 5.3 percent in non-IP-intensive industries (Table 9).

[44] U.S. International Trade Commission and U.S. Bureau of Labor Statistics.

[45] U.S. Census Bureau, "Exports from Manufacturing Establishments." The U.S. Census Bureau reports export-supporting-relating activities for 2002, 2003, 2005, and 2006. Export value data published by the U.S. Census Bureau are 10-12 percent lower than export value data published by the U.S. International Trade Commission.

Table 9. Manufacturing Industries: Export-Related Activities, 2002–06[46]

	Exports as % of All		Direct Exports as % of All		Supporting Exports as % of All	
	Shipments	Employment	Shipments	Employment	Shipments	Employment
All Industries	18.3%	18.3%	13.0%	12.3%	5.3%	5.9%
IP-Intensive	22.4	27.6	17.1	21.0	5.4	6.6
Non-IP-Intensive	14.8	14.7	9.4	9.0	5.3	5.7

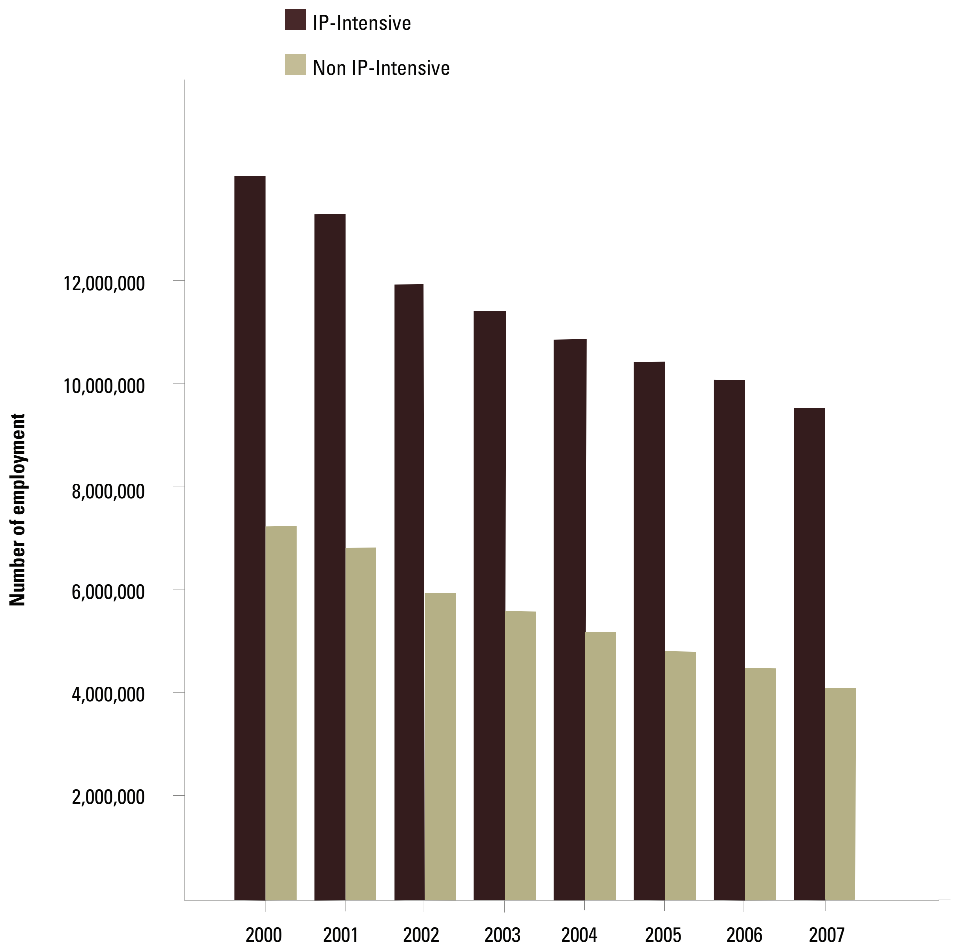
Employment, Production Workers, and R&D Scientists and Engineers

Employment. IP creates higher outputs and sales for the companies that own the IP rights. With higher outputs and sales, companies hire more highly-skilled and more low-skilled workers. Employment in IP-intensive industries exceeded than in non-IP-intensive industries in the last decade. The 27 U.S. tradable industries employed an average 14.7 million persons during 2000-07. During the period, the United States lost more than 3.1 million jobs in tradable industries--an 18.7 percent decline from the 2000 employment level.

Non-IP-intensive industries lost jobs every year in all industries and did not see any indication that the trend would be reversed. During 2000-07, 15 non-IP-intensive industries lost almost 2.3 million jobs, a 19.2 percent decline, from 11.7 million in 2000 to 9.4 million in 2007. Relative to non-IP-intensive industries, the labor market was better in IP-intensive industries. About 30 percent of jobs in tradable industries were in 15 IP-intensive industries. During 2000-07, these industries employed an average 4.475 million workers. IP-intensive industries lost 882,635 jobs, a 17.4 percent decline. The dot-com bubble peaked in March 2000 and badly hurt the computer industry, leading to a job contraction of nearly 24 percent in 2002, compared with a 9.8 percent decline in all 27 tradable industries. Excluding the computer industry, jobs in IP-intensive industries dropped by 10.5 percent during 2000-07 (Figure 11).

[46] U.S. Census Bureau.

Figure 11. Annual Employment in IP- and Non-IP-Intensive Industries, 2000–07[47]



Evidence shows that IP created jobs. During 2000-07, all U.S. tradable industries cut jobs except three industries. Those that created jobs (41,302) were all IP-intensive: pharmaceuticals created 13,878 jobs, information software 15,190, and medical equipment 12,234. During the same period, the highest rate of job loss was in the textile, apparel and leather industry, a non-IP-intensive industry. By 2007, the textile, apparel and leather industry lost 582,872 jobs, reaching a level 51.4 percent below 2000 (Table 10).

[47] U.S. International Trade Commission and U.S. Bureau of Labor Statistics.

Table 10. Employment, by Industry, 2000–07[48]

	Average 2000-07	2000	2007	Job Creation/ Losses (+/-)	% Change in 2000 Level
All Tradable Industries	**14,759,400**	**16,805,479**	**13,666,847**	**-3,138,632**	**-18.7%**
IP-Intensive	***4,475,166***	***5,060,828***	***4,178,193***	***-882,635***	***-17.4%***
Petroleum, coal products	102,942	109,223	103,577	-5,646	-5.2
Chemicals	832,073	885,848	793,717	-92,131	-10.4
Basic chemicals	171,640	191,979	165,025	-26,954	-14.0
Resin, synthetic rubber, fibers	97,566	113,573	88,601	-24,972	-22.0
Pharmaceuticals, medicines	241,994	227,461	241,339	13,878	6.1
Computer, electronic products	1,238,549	1,557,087	1,043,288	-513,799	-33.0
Computers, peripheral equipment	144,205	193,897	99,137	-94,760	-48.9
Communications equipment	186,822	256,501	151,847	-104,654	-40.8
Semiconductor	435,562	571,377	362,859	-208,518	-36.5
Navigational, electro-medical	412,984	461,516	384,966	-76,550	-16.6
Transportation equipment	1,658,753	1,872,630	1,574,147	-298,483	-15.9
Motor vehicles, trailers	1,042,386	1,198,065	941,711	-256,354	-21.4
Aerospace products	403,496	446,243	408,139	-38,104	-8.5
Miscellaneous medical equipment	307,356	304,555	316,789	12,234	4.0
Information software	335,493	331,485	346,675	15,190	4.6
Non-IP-Intensive	***10,284,229***	***11,744,651***	***9,488,654***	***-2,255,997***	***-19.2%***
Food, beverage, tobacco	1,625,869	1,637,484	1,595,380	-42,104	-2.6
Textiles, apparel, leather	789,043	1,134,057	551,185	-582,872	-51.4
Wood products	551,000	597,684	527,565	-70,119	-11.7
Paper, printing	1,182,400	1,367,332	1,056,867	-310,465	-22.7
Plastics, rubber products	934,068	1,056,507	855,483	-201,024	-19.0
Nonmetallic mineral products	485,865	523,698	472,128	-51,570	-9.8
Primary metals	493,207	601,627	438,921	-162,706	-27.0
Fabricated metal products	1,602,107	1,790,817	1,565,866	-224,951	-12.6
Machinery	1,183,201	1,377,950	1,137,540	-240,410	-17.4
Electrical equipment, appliances	477,381	589,406	406,259	-183,147	-31.1
Furniture	570,384	640,444	517,401	-123,043	-19.2
Misc non-medical equipment	389,705	427,645	364,059	-63,586	-14.9

[48] U.S. Census Bureau.

Production Workers (Low-Skilled Workers). Employment comprises all different levels of full-time and part-time employees on the payroll of business establishments. Production workers typically have lower-level skills and command lower wages. Production workers include only workers (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping, maintenance, repair, janitorial and guard services, product development, auxiliary production for plants' own use, recordkeeping, and other services closely associated with production operations.[49]

IP creates low-skilled as well as high-skilled jobs. The Census Bureau reports that the number of production workers (excluding employees above the working-supervision level) during 2000-07 averaged 9.5 million, equal to about 65 percent of total employment in all U.S. tradable industries. Low-skilled jobs in U.S. tradable industries declined by 22.2 percent during this period, with IP-intensive industries cutting 22.7 percent and non-IP-intensive industries shedding 22 percent. Low-skilled jobs in the computer industry dropped the most, by 41.7 percent, mostly in 2000-01 as a result of the bursting of the dot-com bubble. Excluding the computer industry, low-skilled jobs in IP-intensive industries fell only 15 percent during 2000-07, versus a 22 percent decline in non-IP-intensive industries (Table 10).

While all non-IP-intensive industries lost low-skilled jobs during 2000-07, two IP-intensive industries created 6,292 low-skilled jobs. During 2000-07, pharmaceuticals created 5,150 low-skilled jobs over this period and the IP-intensive petroleum and coal industry created 1,142 low-skilled jobs (Table 11).

[49] U.S. Census Bureau.

Table 11. Production Workers, by Industry, 2000–07[50]

	Average 2000-07	2000	2007	Job Creation/ Losses (+/-)	% Change in 2000 Level
All Tradable Industries	**9,464,202**	**11,943,646**	**9,296,953**	**-2,646,693**	**-22.2%**
IP-Intensive	***1,892,765***	***2,975,007***	***2,300,941***	***-674,066***	***-22.7%***
Petroleum, coal products	66,032	67,130	68,272	1,142	1.7
Chemicals	467,248	510,797	463,802	-46,995	-9.2
Basic chemicals	99,037	109,825	96,470	-13,355	-12.2
Resin, synthetic rubber, fibers	64,436	73,715	67,475	-6,240	-8.5
Pharmaceuticals, medicines	116,816	116,816	121,966	5,150	4.4
Computer, electronic products	581,787	853,295	497,895	-355,400	-41.7
Computers, peripheral equipment	46,667	76,543	33,896	-42,647	-55.7
Communications equipment	74,281	128,948	54,654	-74,294	-57.6
Semiconductor	257,440	397,169	222,854	-174,315	-43.9
Navigational, electro-medical	164,802	199,779	158,622	-41,157	-20.6
Transportation equipment	1,171,958	1,351,740	1,081,651	-270,089	-20.0
Motor vehicles, trailers	817,668	954,777	709,272	-245,505	-25.7
Aerospace products	201,450	229,243	211,686	-17,557	-7.7
Miscellaneous medical equipment	187,526	192,045	189,321	-2,724	-1.4
Information software	--	--	--	--	--
Non-IP-Intensive	***7,570,875***	***8,964,137***	***6,996,012***	***-1,968,125***	***-22.0%***
Food, beverage, tobacco	1,205,631	1,239,628	1,196,768	-42,860	-3.5
Textiles, apparel, leather	616,835	949,261	403,025	-546,236	-57.5
Wood products	439,980	486,245	417,471	-68,774	-14.1
Paper, printing	859,610	1,022,056	776,445	-245,611	-24.0
Plastics, rubber products	736,434	857,415	662,001	-195,414	-22.8
Nonmetallic mineral products	373,491	407,057	365,926	-41,131	-10.1
Primary metals	373,072	459,111	344,652	-114,459	-24.9
Fabricated metal products	1,175,523	1,375,118	1,179,280	-195,838	-14.2
Machinery	747,350	914,999	739,449	-175,550	-19.2
Electrical equipment, appliances	335,057	430,902	296,191	-134,711	-31.3
Furniture	441,704	513,666	388,495	-125,171	-24.4
Misc non-medical equipment	266,189	308,679	226,309	-82,370	-26.7

[50] U.S. Census Bureau.

Between 2000 and 2007, low-skilled jobs in U.S. tradable industries declined by almost 2.7 million from over 11.9 million jobs to less than 9.3 million jobs in 2007. The 22.2 percent shrinkage in low-skilled jobs occurred largely during 2000-04 and the job level was relatively flat during 2004-07. During 2000-04, every U.S. tradable industry cut jobs. The low-skilled jobs lost in all tradable industries reached almost 2.7 million, accounting for 21.6 percent of total production employment in 2000. IP-intensive industries cut almost 700,000 production jobs, with 376,636 in the computer industry alone. Non-IP-intensive industries cut almost 1.9 million production jobs, accounting for 21.1 percent of total employment in 2000 (Table 12).

During 2004-07 (the contraction period of the business cycle), the number of low-skilled jobs in all tradable industries fell by 68,177, 0.7 percent below the 2004 level. But all 10 IP-intensive industries, including the computer industry, added more than 8,000 production jobs. While five non-IP-intensive industries also added low-skilled jobs, seven other non-IP-intensive industries continued shedding low-skilled jobs. As a result, non-IP-intensive industries lost 76,194 low-skilled jobs during 2004-07 (Table 12).

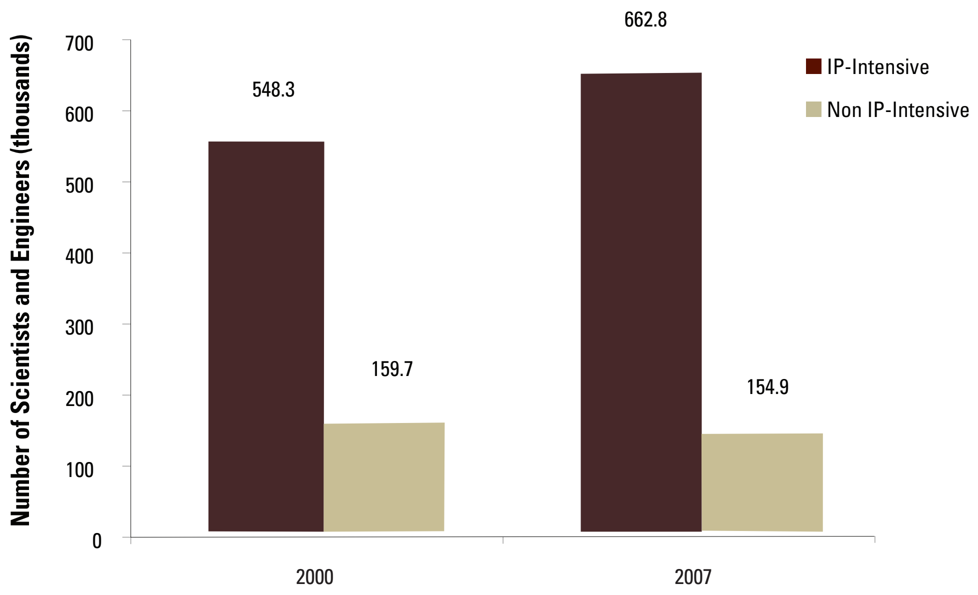
Table 12. Production Workers Job Growth Rates, by Industry, 2000–07[51]

	2000-07	2000-04	2004-07
All Tradable Industries	**-22.2%**	**-21.6%**	**-0.7%**
IP-Intensive	***-22.7%***	***-22.9%***	***0.3%***
Petroleum, coal products	1.7	-6.6	8.9
Chemicals	-9.2	-14.1	5.8
Basic chemicals	-12.2	-13.8	1.9
Resin, synthetic rubber, fibers	-8.5	-20.4	15.1
Pharmaceuticals, medicines	4.4	-3.4	8.1
Computer, electronic products	-41.7	-44.1	4.5
Computers, peripheral equipment	-55.7	-54.6	-2.5
Communications equipment	-57.6	-57.0	-1.4
Semiconductor	-43.9	-48.9	9.8
Navigational, electro-medical	-20.6	-26.0	7.3
Transportation equipment	-20.0	-15.9	-4.8
Motor vehicles, trailers	-25.7	-15.5	-12.0
Aerospace products	-7.7	-20.0	15.5
Miscellaneous medical equipment	-1.4	-7.2	6.2
Information software	--	--	--
Non-IP-Intensive	***-22.0%***	***-21.1%***	***-1.1%***
Food, beverage, tobacco	-3.5	-5.0	1.6
Textiles, apparel, leather	-57.5	-43.9	-24.4
Wood products	-14.1	-11.6	-2.9
Paper, printing	-24.0	-21.1	-3.7
Plastics, rubber products	-22.8	-19.4	-4.2
Nonmetallic mineral products	-10.1	-12.9	3.2
Primary metals	-24.9	-25.4	0.7
Fabricated metal products	-14.2	-21.3	9.0
Machinery	-19.2	-26.9	10.5
Electrical equipment, appliances	-31.3	-29.0	-3.2
Furniture	-24.4	-17.0	-8.9
Misc non-medical equipment	-26.7	-17.2	-11.4

[51] U.S. Census Bureau.

R&D Scientists and Engineers. The number of scientists and engineers in tradable industries rose 15.5 percent during 2000-07, from 708,000 to 817,600. During this period, IP-intensive industries added 114,500 scientists and engineers, a 20.9 percent increase. In contrast, non-IP-intensive industries cut 4,800 scientists and engineers, recording a 3 percent decline (Figure 12).

Figure 12. Annual Scientists and Engineers in IP- and Non-IP-Intensive Industries, 2000 and 2007[52]



[52] National Science Foundation.

Among 27 tradable industries, the top three industries with the highest growth in scientists and engineers were all IP-intensive industries. During 2000-07, the three IP-intensive industries with the fastest growth in scientists and engineers were: pharmaceuticals (160.1 percent), computer equipment (126.3 percent), and aerospace products (124.6 percent) (Table 13).

Table 13. Scientists and Engineers, by Industry, 2000–07[53]

	Average 2000-07 ('000)	2000 ('000)	2007 ('000)	Job Creation/ Losses (+/-)	% Change in 2000 Level
All Tradable Industries	**753.5**	**708.0**	**817.6**	**109.6**	**15.5%**
IP-Intensive	***591.2***	***548.3***	***662.8***	***114.5***	***20.9%***
Petroleum, coal products	4.3	3.0	4.7	1.7	56.7
Chemicals	110.4	81.5	139.6	58.1	71.3
Basic chemicals	10.3	9.3	13.8	4.5	48.4
Resin, synthetic rubber, fibers	9.2	11.1	4.9	-6.2	-55.9
Pharmaceuticals, medicines	72.8	39.6	103.0	63.4	160.1
Computer, electronic products	252.1	267.6	276.5	8.9	3.3
Computers, peripheral equipment	2.4	15.6	35.3	19.7	126.3
Communications equipment	58.1	101.5	55.1	-46.4	-45.7
Semiconductor	86.1	83.3	91.8	8.5	10.2
Navigational, electro-medical	77.1	63.5	90.4	26.9	42.4
Transportation equipment	126.8	99.5	121.4	21.9	22.0
Motor vehicles, trailers	82.7	73.5	71.4	-2.1	-2.9
Aerospace products	35.0	19.1	42.9	23.8	124.6
Miscellaneous medical equipment	15.9	15.7	20.1	4.4	28.0
Information software	93.5	81.0	100.5	19.5	24.1
Non-IP-Intensive	***160.0***	***159.7***	***154.9***	***-4.8***	***-3.0%***
Food, beverage, tobacco	13.3	13.0	13.5	0.5	3.8
Textiles, apparel, leather	5.1	2.5	6.3	3.8	152.0
Wood products	1.5	2.0	1.5	-0.5	-25.0
Paper, printing	12.8	11.1	8.5	-2.6	-23.4
Plastics, rubber products	12.4	11.5	12.6	1.1	9.6
Nonmetallic mineral products	6.5	6.9	5.8	-1.1	-15.9
Primary metals	4.2	4.7	3.8	-0.9	-19.1
Fabricated metal products	15.3	10.1	16.0	5.9	58.4
Machinery	59.5	55.9	58.8	2.9	5.2
Electrical equipment, appliances	19.0	33.6	15.6	-18.0	-53.6
Furniture	2.9	2.2	3.5	1.3	59.1
Misc non-medical equipment	7.5	6.2	9.0	2.8	45.2

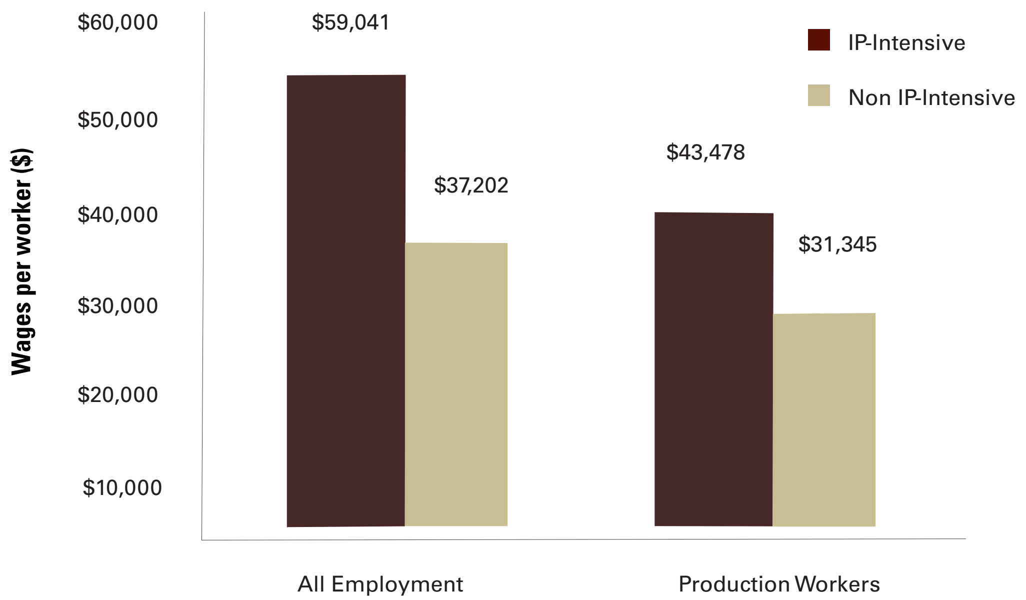
[53] National Science Foundation.

Employment Wages and Low-Skilled Production Worker Wages

Wage data from the U.S. Census Bureau reflect the gross earnings of workers on payrolls used to calculate the federal withholding tax. The Census data include all forms of compensation--including salaries, wages, commissions, dismissal pay, bonuses, vacation and sick leave pay, and compensation in kind--before deducting such things as employees' social security contributions, withholding taxes, group insurance, union dues, and savings bonds. Employment wages represent gross earnings of all employees (including officers of corporations) while production worker wages reflect gross earnings of only production workers.[54]

During 2000-07, average annual employee wages were $43,825 and annual low-skilled production wages were $34,330 in all 27 tradable industries. Annual wages paid to employees and low-skilled production workers in 15 IP-intensive industries exceeded wages paid to employees and low-skilled production workers in 12 non-IP-intensive industries. Annual wages averaged $59,041 per employee in IP-intensive industries versus $37,202 in non-IP-intensive industries. The wage differential ($21,839 per employee) was 58.7 percent above wages paid in non-IP-intensive industries. Similarly, low-skilled production workers in IP-intensive industries received higher average annual wages ($43,478) than low-skilled production workers in non-IP-intensive industries ($31,345). The wage differential of low-skilled production workers was $12,133 per worker, 38.7 percent above wages paid in non-IP-intensive industries (Figure 13).

Figure 13. Annual Average Wage per Worker in IP-Intensive and Non-IP-Intensive Industries, All Employment and Production Workers, 2000–07[55]



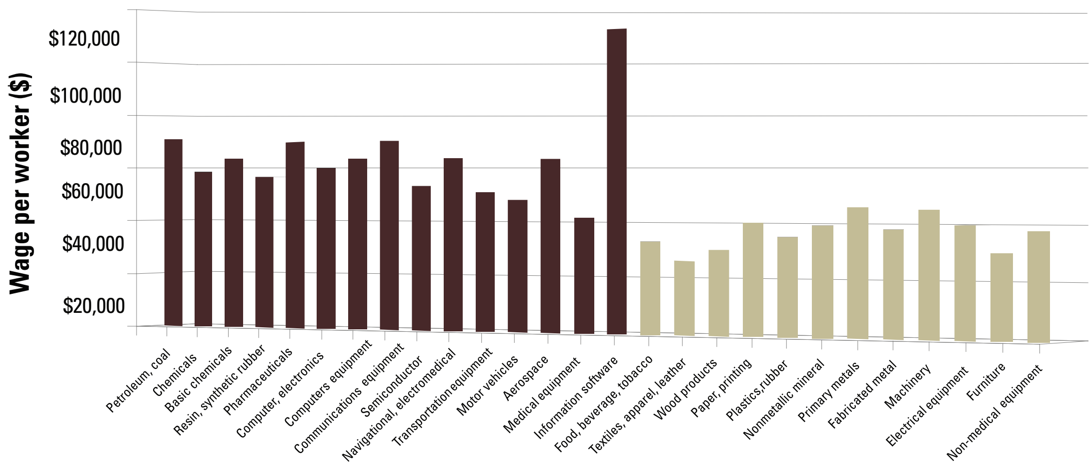
[54] U.S. Census Bureau.

[55] National Science Foundation.

Every IP-intensive industry (except medical equipment) paid employment wages higher than any non-IP-intensive industry. The average wage in information software was $110,052, which was the highest salary and more than 2.5 times the average of 27 tradable industries and almost three times the average of non-IP-intensive industries (Figure 14 and Table 14).

In contrast, wages in 10 of 12 non-IP-intensive industries were lower than the average for all tradable industries. The average wage in the non-IP-intensive textile industry was $26,695, the lowest salaries among tradable industries and some 40 percent below the average wage in 27 tradable industries (Figure 14 and Table 14).

Figure 14. Average Wage per Employee, by Industry in 2000-07[56]



[56] National Science Foundation.

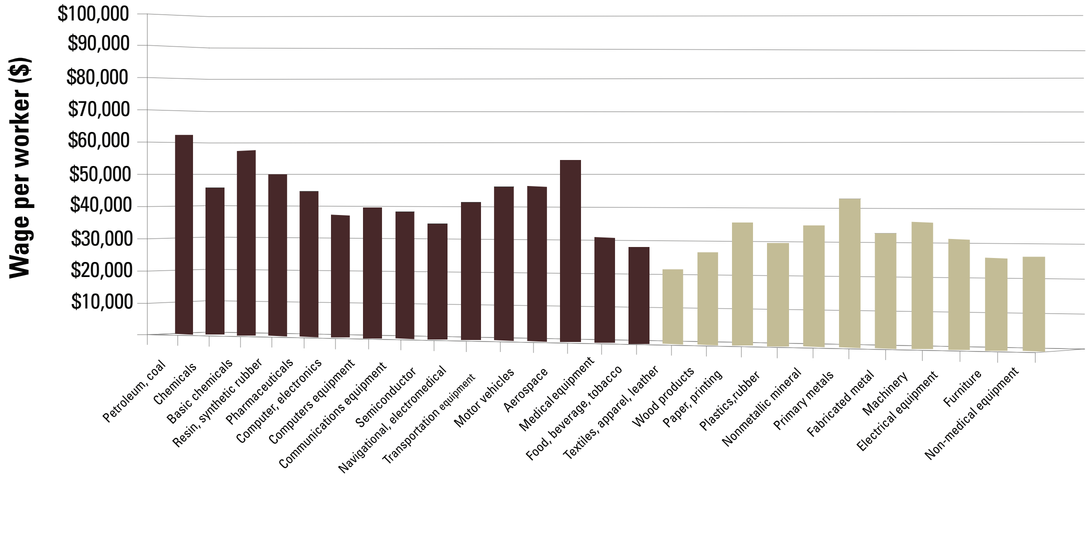
Table 14. Employment Wage per Employee, 2000–07[57]

	Wages ($)	Employment	Wage per Employee ($)	Wage as % of Value Added (%)
All Tradable Industries	**$644,253,276**	**14,759,400**	**$43,825**	**30.2%**
IP-Intensive	***$263,379,460***	***4,475,166***	***$59,041***	***27.6%***
Petroleum, coal products	$7,288,013	102,942	70,855	9.5%
Chemicals	48,444,941	832,073	58,372	16.7%
Basic chemicals	10,857,092	171,640	63,490	17.9%
Resin, synth rubber, fibers	5,483,823	97,566	56,491	19.6%
Pharmaceuticals, medicines	16,903,974	241,994	69,689	14.8%
Computer, electronic products	73,474,144	1,238,549	59,982	32.4%
Computers equipment	8,957,49	144,205	63,425	25.9%
Communications equipment	12,865,108	186,822	70,036	32.9%
Semiconductor	23,027,606	435,562	53,328	29.2%
Navigational, electromedical	26,159,240	412,984	63,667	38.9%
Transportation equipment	84,285,031	1,658,753	50,919	33.3%
Motor vehicles, trailers	50,171,303	1,042,386	48,211	31.5%
Aerospace products	25,444,660	403,496	63,219	36.2%
Miscellaneous medical equipment	12,927,400	307,356	42,012	27.5%
Information software	36,959,930	335,493	110,052	59.1%
Non-IP-Intensive	***$380,873,816***	***10,284,229***	***$37,202***	***32.4%***
Food, beverage, tobacco	54,351,435	1,625,869	33,444	18.7%
Textiles, apparel, leather	20,695,010	789,043	26,695	37.9%
Wood products	16,958,940	551,000	30,816	43.0%
Paper, printing	47,743,212	1,182,400	40,573	35.0%
Plastics, rubber products	33,127,209	934,068	35,602	35.3%
Nonmetallic mineral products	19,289,096	485,865	39,776	31.7%
Primary metals	22,613,094	493,207	46,222	33.1%
Fabricated metal products	61,385,925	1,602,107	38,414	40.3%
Machinery	53,424,189	1,183,201	45,338	37.8%
Electrical equip, appliances	18,979,566	477,381	40,142	33.7%
Furniture	17,396,230	570,384	30,625	39.8%
Misc non-medical equip	14,909,911	389,705	38,340	40.6%

[57] U.S. Census Bureau.

IP-intensive industries also paid higher wages for their low-skilled workers during 2000-07. Annual wages of low-skilled production workers in IP-intensive industries ($43,478) also exceeded wages of low-skilled production workers in non-IP-intensive industries ($31,345). Annual wages in the IP-intensive petroleum and coal industry were $62,337, which was the highest salary for low-skilled workers and 82 percent above the tradable industry average. In contrast, low-skilled production workers in the textile industry were paid an average $22,085 a year, the lowest salary for low-skilled workers and almost 40 percent below the tradable industry average (Figure 15 and Table 15).

Figure 15. Annual Average Production Wage per Production Worker, by Industry, 2000–07[58]



[58] U.S. Census Bureau.

Table 15. Annual Average Production Wage per Production Worker, by Industry, 2000–07[59]

	Production Wages ($)	Production Workers	Production Wage per Production Worker ($)	Production Wage as % of Value Added (%)
All Tradable Industries	**$342,351,091**	**10,045,989**	**$34,330**	**16.1%**
IP-Intensive	***$106,771,860***	***2,474,551***	***$43,478***	***11.2%***
Petroleum, coal products	4,112,439	66,032	62,337	5.4
Chemicals	21,320,580	467,248	45,847	7.3
Basic chemicals	5,655,944	99,037	57,370	9.3
Resin, synth rubber, fibers	3,209,145	64,436	50,079	11.5
Pharmaceuticals, medicines	5,237,278	116,816	44,862	4.6
Computer, electronic products	21,451,657	581,787	37,515	9.4
Computers equipment	1,830,194	46,667	39,841	5.3
Communications equipment	2,827,881	74,281	38,531	7.2
Semiconductor	8,804,505	257,440	34,996	11.2
Navigational, electromedical	6,814,493	164,802	41,660	10.1
Transportation equipment	54,039,771	1,171,958	46,298	21.4
Motor vehicles, trailers	37,762,086	817,668	46,377	23.7
Aerospace products	10,905,671	201,450	54,391	15.5
Miscellaneous medical equipment	5,847,413	187,526	31,270	12.4
Information software	--	--	--	--
Non-IP-Intensive	***$235,579,232***	***7,570,875***	***$31,345***	***20.0%***
Food, beverage, tobacco	34,485,138	1,205,631	28,645	11.8
Textiles, apparel, leather	13,273,573	616,835	22,085	24.3
Wood products	11,933,306	439,980	27,201	30.3
Paper, printing	30,538,418	859,60	35,778	22.4
Plastics, rubber products	21,953,195	736,434	30,023	23.4
Nonmetallic mineral products	13,084,090	373,491	35,119	21.5
Primary metals	15,889,352	373,072	42,955	23.3
Fabricated metal products	38,500,537	1,175,523	32,929	25.2
Machinery	26,938,530	747,350	36,278	19.1
Electrical equip, appliances	10,439,642	335,057	31,502	18.5
Furniture	11,493,551	441,704	26,223	26.3
Misc non-medical equipment	7,049,900	266,189	26,751	19.2

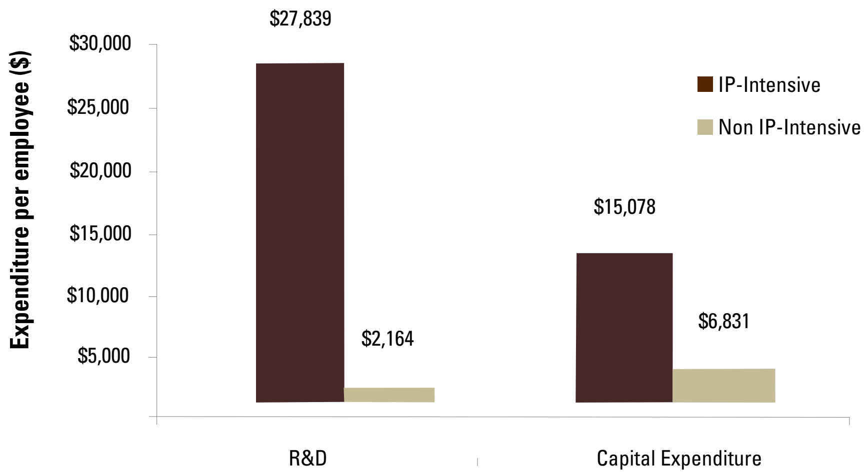
[59] U.S. Census Bureau.

Capital Expenditures

In addition to R&D spending, IP-intensive industries allocated more to capital expenditure per employee than non-IP-intensive industries. Capital expenditures fall under two broad categories: machinery and equipment and buildings and other structures. Machinery and equipment consists of spending on new and used machinery and equipment, including automobiles and other vehicles, computers, peripheral data processing, and any other equipment used for replacement and additions to plant capacity. Spending on buildings and other structures include permanent additions and major alterations to establishments. Machinery and equipment are produced in tradable sectors whereas buildings and other structures are produced in non-tradable sectors.[62] Since components of capital expenditure consist of all tradable (i.e. computers and cars) and non-tradable (i.e. buildings and structures) products in both IP-intensive and non-IP-intensive industries, higher capital expenditure created more jobs and stimulated higher economic growth.

Total capital expenditures, as published by the U.S. Census Bureau, represent total new and used capital spending reported by establishments in operation and plants under construction. During 2000-07, total capital expenditures for all 27 tradable industries averaged $137 billion a year and $9,333 per employee. Fifteen IP-intensive industries were also allocating more to capital expenditure per employee than 12 non-IP-intensive industries. During 2000-07, annual capital expenditure averaged $15,078 per employee in IP-intensive industries, more than double annual spending of $6,831 in 12 non-IP-intensive industries (Figure 16).

Figure 16. R&D and Capital Expenditure per Employee, IP- and Non-IP-Intensive Industries, 2000–07[60]



Capital expenditure per employee of IP-intensive industries exceeded the average for all 27 tradable industries. Petroleum, an IP-intensive industry, averaged $90,039 capital expenditure per employee, the highest among all 27 tradable industries. In contrast, capital expenditure for 10 non-IP-intensive industries was below the average for all tradable industries. The seven industries reporting the lowest capital spending per employee were all non-IP-intensive (Table 16).

[60] National Science Foundation and U.S. Census Bureau.

Table 16. Annual Average Capital Expenditure, by Industry, 2000–07[61]

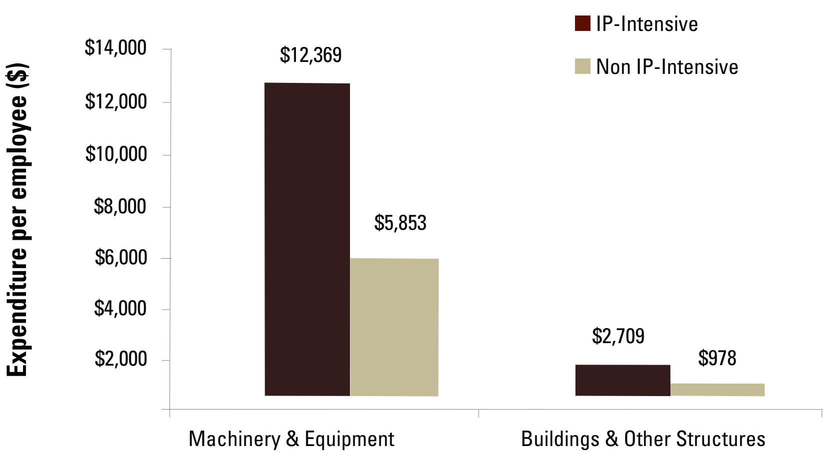
	Total Capital Expenditure ($ millions)	Capital Expenditure per Employee ($)	Capital Expenditure as % of Value Added (%)
All Tradable Industries	**$137,464**	**$9,333**	**6.4%**
IP-Intensive	***$67,402***	***$15,078***	***7.1%***
Petroleum, coal products	9,254	90,039	12.1
Chemicals	18,513	22,292	6.4
Basic chemicals	5,814	34,004	9.6
Resin, synth rubber, fibers	2,645	27,393	9.5
Pharmaceuticals, medicines	6,003	24,845	5.2
Computer, electronic products	17,277	13,750	7.6
Computers equipment	1,814	12,871	5.2
Communications equipment	2,205	11,067	5.6
Semiconductor	9,423	21,124	12.0
Navigational	3,186	7,746	4.7
Transportation equipment	15,902	9,596	6.3
Motor vehicles, trailers	12,272	11,770	7.7
Aerospace products	2,646	6,590	3.8
Miscellaneous medical equipment	2,371	7,708	5.0
Information software	4,085	12,110	6.5
Non-IP-Intensive	***70,062***	***6,831***	***6.0%***
Food, beverage, tobacco	14,854	9,142	5.1
Textiles, apparel, leather	2,311	2,929	4.2
Wood products	2,840	5,142	7.2
Paper, printing	10,517	8,948	7.7
Plastics, rubber products	7,165	7,678	7.6
Nonmetallic mineral products	5,662	11,663	9.3
Primary metals	4,997	10,239	7.3
Fabricated metal products	8,374	5,220	5.5
Machinery	7,241	6,099	5.1
Electrical equip, appliances	2,723	5,685	4.8
Furniture	1,562	2,733	3.6
Misc non-medical equip	1,816	4,682	4.9

[61] U.S. Census Bureau.

Capital expenditure accounted for 6.4 percent of value-added for all 27 tradable industries. IP-intensive industries reported 7.1 percent, as against 6 percent of value added in non-IP-intensive industries. Capital expenditure in the IP-intensive petroleum and semiconductor industries was more than 12 percent of their value added, almost two times the industry average (Table 16).

IP-intensive industries spend more capital per employee a year in both machinery & equipment and buildings & other structures and therefore have higher economic impacts on other tradable and non-tradable industries. On average, IP-intensive industries spend $12,369 per employee on machinery and equipment and $2,709 per employee on buildings and other structures. Non-IP-intensive industries, however, spent only $5,853 per employee on machinery and equipment and $978 per employee on buildings and structures (Figure 17 and Table 17).

Figure 17. Annual Average Capital Expenditure: Machinery & Equipment and Buildings & Other Structures per Employee, IP- and Non-IP-Intensive Industries, 2000–07[63]



[62] U.S. Census Bureau.
[63] U.S. Census Bureau.

Table 17. Annual Average Capital Expenditure: Machinery & Equipment and Buildings & Other Structures, by Industry, 2000–07[64]

	Machinery & Equipment		Buildings & Other Structures per Employee	
	$ millions	per employee ($)	$ millions	per employee ($)
All Tradable Industries	**$115,286**	**$7,830**	**$22,178**	**$1,503**
IP-Intensive	***$55,231***	***$12,369***	***$12,171***	***$2,709***
Petroleum, coal products	7,678	74,722	1,575	15,318
Chemicals	15,097	18,175	3,416	4,116
Basic chemicals	5,251	30,679	563	3,325
Resin, synth rubber, fibers	2,421	25,076	224	2,317
Pharmaceuticals, medicines	4,019	16,617	1,984	8,229
Computer, electronic products	13,929	11,141	3,348	2,610
Computers equipment	1,500	10,680	313	2,191
Communications equipment	1,690	8,444	515	2,623
Semiconductor	7,747	17,587	1,676	3,538
Navigational, electromedical	2,428	5,907	758	1,839
Transportation equipment	13,596	8,204	2,306	1,392
Motor vehicles, trailers	10,892	10,447	1,380	1,324
Aerospace products	1,960	4,870	686	1,719
Miscellaneous medical equipment	1,897	6,168	474	1,539
Information software	3,034	9,011	1,051	3,099
Non-IP-Intensive	***$60,050***	***$5,853***	***$10,012***	***$978***
Food, beverage, tobacco	12,018	7,395	2,836	1,747
Textiles, apparel, leather	1,998	2,522	313	408
Wood products	2,378	4,305	463	837
Paper, printing	9,479	8,061	1,037	887
Plastics, rubber products	6,367	6,821	798	857
Nonmetallic mineral products	4,869	10,032	793	1,631
Primary metals	4,322	8,857	675	1,381
Fabricated metal products	7,311	4,555	1,063	665
Machinery	6,133	5,173	1,108	926
Electrical equip, appliances	2,388	4,982	335	703
Furniture	1,254	2,194	307	539
Misc non-medical equip	1,533	3,949	283	733

[64] U.S. Census Bureau.

IV. THREATS TO INNOVATION AND INTELLECTUAL PROPERTY

Intellectual property includes such intangible assets as patents, design rights, customer lists, and business assets–such as stocks, plants, and machinery. IP is vulnerable to theft by third parties or even staff. Companies and individuals may steal innovations from other business entities to produce fake products or generic versions. Employees may reveal important customer lists, patent information, or any design rights to third parties knowingly or unknowingly. From electronics to pharmaceuticals, every industry is affected directly or indirectly by intellectual property fraud.

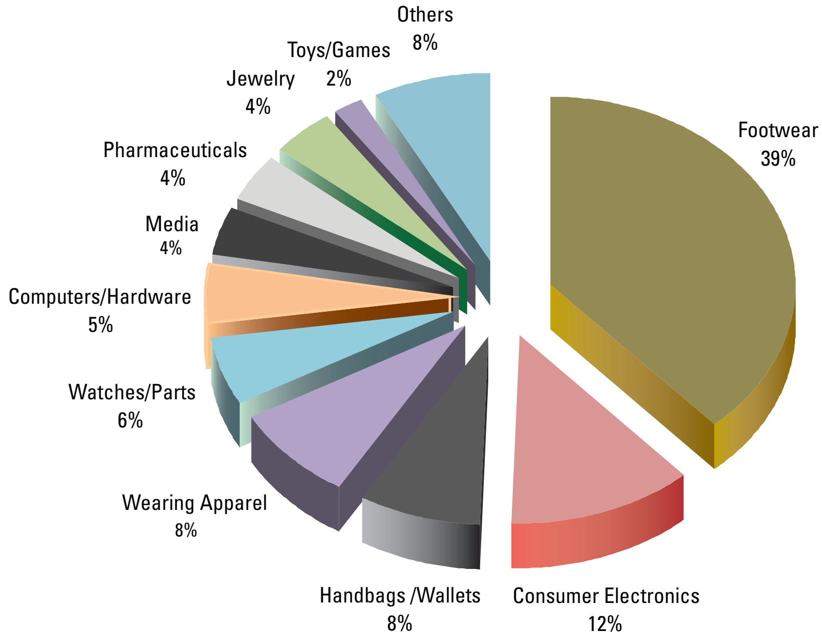
Threats to protected patents, trade secrets, copyrights, and trademarks fall under two broad categories: counterfeiting and piracy.

Counterfeiting

Counterfeit products are "fakes" manufactured and sold as if they were the genuine item. Counterfeiters attempt either to deceive consumers or to appeal to those who do not care about having the genuine article, and thus do not value intellectual property rights. Counterfeit products sell at a premium, with high profit margins, because of the value, prestige, and quality associated with the authentic good. However, the infringed brand and trademark are harmed when counterfeit goods fail to meet consumers' expectations of quality or performance associated with the authentic good. For luxury items, the brand value can be tarnished as counterfeiting eliminates the exclusivity associated with these items.

The World Customs Organization suggests that all sectors ranging from horticulture to the auto industry are threatened by counterfeit goods. The World Health Organization estimates that 10 percent of all prescription drugs are counterfeit, and Italy's Chamber of Commerce estimates that at least 20 percent of apparel purchased is counterfeit. According to U.S. Customs and Border Protection, the counterfeit products most frequently seen entering the United States in 2009 were footwear, consumer electronics, handbags, apparel, computer hardware, and pharmaceuticals (Figure 18).

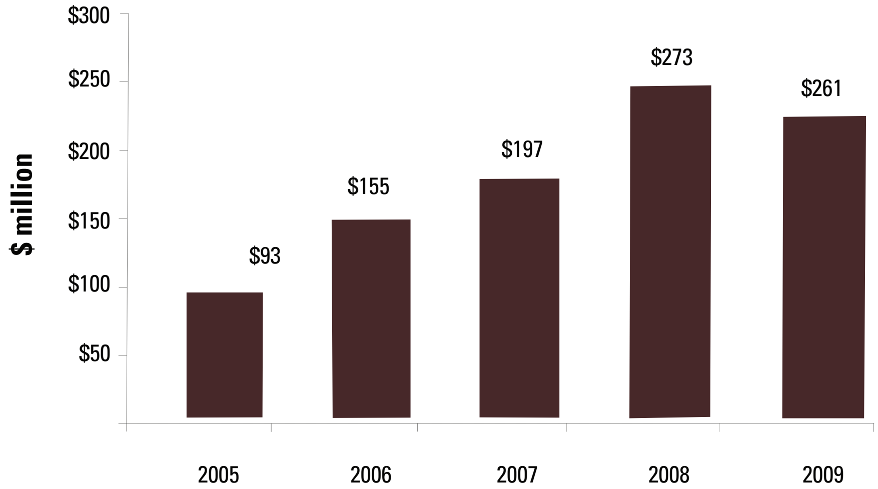
Figure 18. Top Commodities Seized by U.S. Law Enforcement and Customs Authorities[65]



The U.S. Department of Homeland Security reports that the annual domestic value of IPR seizures surged from $93 million in 2005 to $273 million in 2008, falling somewhat to $261 million in 2009, owing to global recession (Figure 19).

[65] Intellectual Property Rights Seizure Statistics: Fiscal Year 2009, U.S. Immigration and Customs Enforcement.

Figure 19. Annual Domestic Value of IPR Seizures, 2005–09[66]



Piracy

Pirated goods—direct or indirect--are copies of a manufacturer's IP. Typical pirated products include books, music, videos, and computer software. Trademarks are pirated when they are registered or used by unauthorized persons in another country. The expansion of, and increased access to, the internet has led to a sharp rise in pirated content. In a 2009 study, IDC, the U.S.-based global market intelligence firm, estimates that 20 percent of PC software in the United States is pirated and that, even so, the country still has the lowest piracy rate. PC software piracy rates of the top 25 countries range from 80 percent in China and El Salvador to 92 percent in Bangladesh--and to 95 percent in Georgia. The IDC study estimates the worldwide monetary value of unlicensed software losses to software vendors at $53 billion in 2008.[67]

The threats to IP from counterfeiting and piracy come from the suppliers and consumers of the products. In 2008, a major study by the Organisation for Economic Cooperation and Development (OECD) on the economic impact of counterfeiting and piracy reviewed the variables driving supply and demand (Table 18). The report found that the supply of counterfeit and pirated products is driven by such factors as high unit profitability in the market, moderate or low level of investment in technology and distribution, and low risk of discovery by law enforcers.[68] Indeed, firms producing counterfeit goods may also produce legal goods sold through legitimate channels. Counterfeiting and piracy can also occur downstream in the supply chain, away from producers, when packaging and labels are modified. An example would be Chinese auto parts manufactured under a generic label, shipped legally to the United States, and then relabeled "Genuine Ford

[66] Intellectual Property Rights Seizure Statistics: Fiscal Year 2009, U.S. Immigration and Customs Enforcement.
[67] IDC. 2009. "08 Piracy Study." Sixth Annual Business Software Alliance-IDC Global Software.
[68] OECD. 2008. The Economic Impact of Counterfeiting and Piracy. OECD Publishing.

Parts." In a 2009 report on counterfeit and gray market auto-parts distribution, the Motor and Equipment Manufacturers Association found that free trade zones and free ports are another potential location for relabeling or even manufacturing counterfeit and pirated goods.[69]

On the demand side, consumers of counterfeit and pirated goods fall under two categories: those who knowingly purchase these goods and those who are deceived by the illicit goods. The motivations of consumers who buy counterfeit and pirated goods can include low prices, ease of acquisition, the need or desire to save money, and/or having low regard for IPR or perceiving a low risk of getting caught.

Table 18. Drivers of Counterfeit and Pirate Activities[70]

Supply of Counterfeit and Pirated Products	Demand for Counterfeit and Pirated Products
Market characteristics High unit profitability Large potential market size Genuine brand power	**Product characteristics** Low prices Acceptable perceived quality Ability to conceal status
Production, distribution and technology Moderate need for investments Moderate technology requirements Unproblematic distribution and sales High ability to conceal operation Easy to deceive consumers	**Consumer characteristics** No health concerns No safety concerns Needing or wanting to save money
Institutional characteristics Low risk of discovery Legal and regulatory framework Weak enforcement Penalties	**Institutional characteristics** Low risk of discovery and prosecution Weak or no penalties Availability and ease of acquisition Socio-economic factors

Counterfeiting and piracy impose heavy costs on business and society. They cut into the sale of genuine products, force manufacturers to raise the prices of authentic products to cover costs, lower employment, deter investment in R&D as well as capital investment, reduce tax receipts, and raise law enforcement costs. Furthermore, counterfeit food products, over-the-counter medicines, and prescription pharmaceuticals may be hazardous to consumers' health, while fake automotive and aerospace parts can jeopardize consumer safety and national security.

[69] MEMA. 2009. "Understanding the Flow of Counterfeit and Gray Market Goods Though the U.S. Automotive and Commercial Vehicle Parts Marketplace." MEMA Brand Protection Council.

[70] OECD. 2008. The Economic Impact of Counterfeiting and Piracy. OECD Publishing.

The six most commonly-cited negative effects of IPR infringement include:

- ***Lost revenue.*** Legitimate businesses–the backbone of employment and economic growth--suffer sales losses when consumers, knowingly or unknowingly, buy counterfeit or pirated products.

- ***Lost employment.*** Legitimate businesses lose jobs when counterfeit and pirated products establish a presence in the market. IDC estimates that a 10 percent reduction in global computer software piracy would add 600,000 legitimate jobs, contribute $141 billion to global GDP, and raise an additional $24 billion in global tax revenues. A 10 percent reduction in U.S.-based computer software piracy would create 32,031 jobs, add $41 billion to U.S. GDP, and add $6.7 billion to U.S. tax revenues.[71]

- ***Damaged reputation and compromised brand value.*** Even worse for legitimate businesses is the loss in reputation and brand value attributable to counterfeit or pirated products, which makes consumers lose trust in the genuine product.

- ***Health and safety concerns.*** These concerns arise in connection with counterfeit and pirated products ranging from fake auto and aerospace parts to medical devices and pharmaceuticals. Counterfeit drugs in particular pose a major health and safety problem. According to the World Health Organization, between 30 percent and 40 percent of the drugs sold in developing countries—and in some cases up to 50 percent--can be counterfeit. Indeed, hundreds if not thousands of deaths can be attributed to counterfeit medicines.[72]

- ***Discouraged R&D and capital investment.*** Companies invest in R&D to achieve innovations and boost their competitiveness in global markets. Bringing new innovations to market requires large, upfront R&D investments and entails the risk that the competitive gains will not be realized. Counterfeiting and piracy, on the other hand, allow illegitimate firms to avoid the investment and the risk and to reap immediate profits. This discourages legitimate firms from making the R&D investment and, in turn may discourage breakthrough drug innovations that demand large R&D investments. For example, a 2003 study by DiMasi, Hansen and Grabowski estimates that it costs $802 million for a pharmaceutical company to take a drug from Phase I trials through to approval, including the cost of drugs that fail to be approved.[73] Counterfeit drug makers skirt the approval process altogether, use untested substitute chemicals, and steal revenues from legitimate producers.

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[71] IDC. 2007. "IDC Global Software Piracy Study." IDC Piracy Impact Study.

[72] World Health Organization. 2008. "Counterfeit Drugs Kill!" International Medical Products Anti-Counterfeiting Taskforce.

[73] DiMasi, Joseph A., Ronald W. Hansen and Henry G. Grabowski. 2003. "The Price of Innovation: New Estimates of Drug Development Costs." Journal of Health Economics.

- *Reduced tax receipts.* Businesses and employees suffering economic setbacks pay less taxes. The loss of legitimate business revenues and jobs owing to counterfeiting and piracy requires corporations and employees to pay higher taxes. According to a 2009 study commisioned by the International Chamber of Commerce's BASCAP, lost business revenues and jobs from counterfeiting and piracy cost the Group of Twenty (G20) countries about $85 billion annually in lost tax revenues and increased welfare spending.[74]

Although the identification of threats to IP, and its overall consequences, are relatively consistent and easy to grasp, the measurement and impact of IP infringement on firms and on the economy is much more difficult to estimate and comprehend. The OECD estimates that international trade in counterfeit and pirated goods grew from $200 billion in 2005 to $250 billion in 2007.[75] IP experts estimate that when the costs of domestic production and consumption of counterfeiting and piracy, internet digital piracy, health and safety consequences, and other related costs are added to the OECD's estimates for international trade, the overall economic impact of counterfeiting and piracy could top $600 billion.[76]

V. CONCLUSION

We conclude that the creation of intellectual property is the key factor in sustaining economic growth and achieving high living standards, a finding that is consistent with the current literature. Evidence from the United States for the 2000s confirms that intellectual property enhances U.S. productivity, in terms of revenue and value added, and strengthens global competitiveness, as reflected in higher exports.

IP-intensive industries, measured by R&D expenditure as such expenditures are direct inputs for innovation and are the most widely used measures for intellectual property, enjoy higher productivity and greater competitiveness than non-IP intensive industries. While the U.S. job market remains weak, with the unemployment rate stuck at historical highs, IP-intensive industries are creating jobs for scientists and engineers, as well as for low-skilled production workers. In addition to R&D expenditure, IP-intensive industries show more capital expenditure per employee. In this way, IP-intensive industries exert positive effects on other tradable industries (machinery and equipment), as well as on non-tradable industries (buildings and other structures). From a global perspective, innovations in developed countries also have positive effects on factor productivity in developing countries.

To strengthen the U.S. economic position in global markets, U.S. policymakers will need to support policies to encourage innovation. While R&D expenditures by the United States account for 33 percent of global R&D spending--far exceeding the spending of all other countries--seven

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[74] Frontier Economics. 2009. "The Impact of Counterfeiting on Governments and Consumers – Executive Summary." A Report for International Chamber of Commerce.

[75] OECD. 2009. "Magnitude of Counterfeiting and Piracy of Tangible Products: An Update."

[76] International Chamber of Commerce.

[77] According to the National Science Foundation, the next heaviest R&D-spending countries are: Japan (13 percent of global spending), China (9 percent), Germany (6 percent), and France (4 percent). Seven countries that report higher R&D intensity than the United States in descending order are: Israel, Sweden, Finland, Japan, South Korea, Switzerland, and Iceland.

other countries report R&D-intensity levels (R&D as a percent of GDP) above the U.S. level.[77] This suggests the need for the United States to further increase its R&D spending to maintain its advantage in the coming years.

Since industry is the largest source of R&D funding (67 percent) as well as the largest R&D spender (72 percent), such valuable policy incentives as R&D tax credits will continue to encourage applied research and development. U.S. policymakers would also do well in supporting the recent proposals to the Congress of the National Science Board; the Board recommended additional federal funding for basic research, more intellectual interchanges between industry and academia, and new databases to track the impact of the globalization of manufacturing and services on the U.S. economy.[78]

With the growing importance of knowledge as a driving force for innovation and economic expansion worldwide, the protection of intellectual property rights has attracted greater attention and concern. The counterfeiting and piracy of products are rising exponentially and are costing the global economy hundreds of billions of dollars a year in lost revenues and thousands of jobs. The challenge for policymakers is therefore to continue encouraging investment in R&D and human capital in order to promote innovation while at the same time developing the policy instruments and frameworks to better protect intellectual property rights. Policies that enhance law enforcement's ability to detect, investigate, and prosecute IP theft are essential for better protecting intellectual property rights and thereby promoting further innovation. The protection of intellectual property rights will require the effective strengthening of national policies, as well as the international coordination of effective policies and frameworks in such forums as the World Trade Organization.

The United States has demonstrated a commitment to protecting intellectual property rights. The Congress in 2008 passed, and President Bush signed into law, the Prioritizing Resources and Organization for Intellectual Property Act (ProIP Act) that increased both civil and criminal penalties for trademark and copyright infringement. Consequently, the Senate in December 2009 confirmed Victoria Espinel as the first IP enforcement coordinator to oversee the nation's enforcement of intellectual property laws and to protect U.S. intellectual property abroad. And the U.S. House of Representatives recently passed the Cybersecurity Enhancement Act of 2009 to protect intellectual property online.[79] As for cross-border IP theft, this can be addressed by re-authorizing the U.S. Customs and Border Protection Reauthorization Act to enhance the IP enforcement capabilities of the U.S. Department of Homeland Security and to press for internationally coordinated rules in relevant global forums.

U.S. policy action to further encourage IP creation while protecting IP rights will be critical in helping the United States retain its global competitive edge in innovation. This, in turn, is essential for ensuring sustained U.S. economic growth and job creation in the coming years.

[78] National Science Board. 2008. "Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy." National Science Foundation.

[79] GovTrack.us. 2010. "H.R. 4061: Cybersecurity Enhancement Act of 2009." GovTrack.us.

Appendix

Table A.1. Economic Performance per Employee in 27 Tradable Industries, by IP-Intensive and Non-IP-Intensive Industries, 2000–07[80]

	Revenues	Value Added	Exports	Employment	Wages	Capital Exp
IP-Intensive	•	•	•	•	•	•
Petroleum, coal products	•	•	•	•	•	•
Chemicals	•	•	•	•	•	•
Basic chemicals	•	•	•	•	•	•
Resin, synthetic rubber	•	•	•		•	•
Pharmaceuticals	•	•	•	•	•	•
Computer, electronic	•	•	•		•	•
Computers equipment	•	•	•		•	•
Communications equipment	•	•	•		•	•
Semiconductor		•	•		•	•
Navigational, electromedical		•	•	•	•	
Transportation equipment	•	•	•	•	•	•
Motor vehicles, trailers	•	•	•		•	•
Aerospace products	•	•	•	•	•	
Misc medical equipment		•		•		
Information software	•	•		•	•	•
Non-IP-Intensive						
Food, beverage, tobacco	•	•		•		
Textiles, apparel, leather						
Wood products				•		
Paper, printing						
Plastics, rubber products						
Nonmetallic minerals				•		•
Primary metals	•		•		•	•
Fabricated metal				•		
Machinery			•	•	•	
Electrical equip			•			
Furniture						
Misc non-medical equip				•		

"•" indicates that performance is above the average of all 27 tradable subsectors and industries.

[80] National Science Foundation and U.S. Bureau of Labor Statistics.

Table A.2. Industrial R&D Expenditure, by Industry ($ millions)[81]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**125,734**	**125,800**	**114,218**	**123,174**	**148,397**	**159,448**	**174,183**	**188,941**
IP-Intensive	***105,685***	***103,488***	***95,544***	***104,072***	***127,198***	***136,288***	***148,762***	***162,521***
Petroleum and coal products	1,172	1,057	1,233	1,308	1,595	1,442	1,431	1,718
Chemicals	20,768	17,713	20,395	22,693	39,070	42,826	46,119	55,319
Basic chemicals	2,050	1,835	1,710	1,991	2,312	2,179	2,054	3,158
Resin synthentic rubber, fibers	2,842	2,745	2,413	2,390	2,080	2,280	1,963	951
Pharmaceuticals and medicines	12,793	10,137	14,186	15,949	31,444	34,798	38,813	47,624
Computer and electronic products	44,526	44,744	33,411	32,495	40,691	42,463	48,251	49,760
Computers and peripheral equipment	5,162	3,165	3,015	2,561	5,707	4,902	7,289	6,869
Communications equipment	16,156	18,721	9,524	8,932	8,433	9,660	10,911	11,435
Semiconductor	12,787	14,210	11,871	12,607	17,524	18,602	18,534	18,315
Navigational, measuring, electromedical	10,114	7,565	8,549	7,834	7,882	8,325	10,440	12,262
Transportation equipment	22,917	21,004	21,452	26,111	26,019	28,321	30,010	30,974
Motor vehicles, trailers, parts	18,306	16,089	15,199	16,874	15,610	16,025	16,562	16,034
Aerospace products and parts	3,895	4,083	5,349	8,203	9,224	10,928	11,995	13,397
Miscellaneous medical equipment	3,741	5,903	6,179	6,370	3,313	4,343	3,998	5,116
Information software	12,561	13,067	12,874	15,095	16,510	16,893	18,953	19,634
Non IP-Intensive	***20,048***	***22,313***	***18,674***	***19,101***	***21,200***	***23,159***	***25,421***	***26,419***
Food, beverage, tobacco	1,562	1,970	2,204	2,160	2,804	3,249	3,263	2,939
Textiles, apparel, leather	266	255	248	309	568	811	583	796
Wood products	105	181	132	138	152	218	192	202
Paper, printing, support activities	2,700	2,664	2,620	2,909	2,308	2,451	2,793	2,596
Plastics and rubber products	1,675	2,245	1,508	1,729	1,879	1,747	2,217	2,072
Nonmetallic mineral products	845	978	420	470	783	889	936	1,112
Primary metals	598	479	461	518	705	609	638	886
Fabricated metal products	1,631	1,545	1,251	1,329	1,465	1,323	1,432	1,594
Machinery	6,539	6,337	6,366	6,224	6,473	8,422	9,743	9,796
Electrical equipment and appliances	3,390	4,680	1,978	2,002	2,622	2,322	2,215	2,617
Furniture and related products	284	301	251	275	406	400	371	581
Miscellaneous non-medical equipment	453	678	1,235	1,038	1,035	718	1,038	1,228

[81] National Science Foundation.

Table A.3. Value of Shipments (Revenues), by Industry ($ millions) [82]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**4,310,619**	**4,073,236**	**4,018,225**	**4,120,108**	**4,421,232**	**4,863,411**	**5,147,810**	**5,442,014**
IP-Intensive	***1,990,759***	***1,852,756***	***1,837,320***	***1,913,384***	***2,077,906***	***2,345,843***	***2,504,484***	***2,677,540***
Petroleum and coal products	235,134	219,075	215,514	247,119	330,439	475,787	546,811	606,004
Chemicals	449,159	438,410	462,498	487,742	540,883	610,873	657,082	722,494
Basic chemicals	115,708	104,430	109,441	120,663	146,215	172,039	195,007	227,245
Resin synthentic rubber, fibers	68,438	60,638	60,275	64,665	73,884	91,972	94,313	101,374
Pharmaceuticals and medicines	118,028	130,021	142,978	151,927	157,610	169,226	180,934	188,534
Computer and electronic products	510,639	429,471	357,324	352,272	365,545	372,882	390,813	395,410
Computers and peripheral equipment	110,242	89,528	73,807	69,073	63,270	65,005	67,403	64,414
Communications equipment	118,735	102,004	65,065	60,943	61,369	58,914	70,195	64,510
Semiconductor	166,671	124,215	110,235	113,198	116,187	119,379	117,688	122,133
Navigational, measuring, electromedical	97,114	97,169	92,018	93,069	106,161	111,984	118,994	130,786
Transportation equipment	639,861	602,496	636,711	655,872	662,000	690,743	699,034	734,244
Motor vehicles, trailers, parts	471,180	427,176	469,560	491,714	494,567	501,486	500,175	499,058
Aerospace products and parts	127,588	134,867	124,686	120,974	120,983	137,282	143,003	169,944
Miscellaneous medical equipment	53,928	57,766	61,768	65,658	66,777	74,223	78,486	75,684
Information software	102,037	105,538	103,506	104,721	112,261	121,334	132,257	143,704
Non IP-Intensive	***2,319,860***	***2,223,282***	***2,180,905***	***2,206,725***	***2,343,326***	***2,517,568***	***2,643,326***	***2,764,523***
Food, beverage, tobacco	546,922	570,171	563,662	597,597	626,077	656,488	660,972	714,665
Textiles, apparel, leather	155,752	141,084	125,387	118,361	113,219	114,932	108,360	94,499
Wood products	93,669	87,250	89,019	92,069	104,135	112,095	112,403	102,002
Paper, printing, support activities	269,693	256,638	249,366	243,652	248,976	258,850	268,833	279,235
Plastics and rubber products	178,236	170,717	174,675	178,327	184,711	200,304	211,299	211,531
Nonmetallic mineral products	97,329	94,861	95,064	96,945	102,880	114,849	126,263	127,240
Primary metals	156,598	138,245	139,435	138,271	181,602	203,263	234,384	257,851
Fabricated metal products	268,212	253,113	246,847	245,339	261,101	289,432	317,214	345,154
Machinery	291,548	266,553	255,322	257,428	272,123	302,650	326,583	347,930
Electrical equipment and appliances	125,443	114,067	102,844	99,907	105,084	111,977	119,402	129,271
Furniture and related products	75,107	72,147	75,840	75,275	78,279	84,181	85,618	84,990
Miscellaneous non-medical equipment	61,352	58,435	63,444	63,553	65,139	68,547	71,994	70,156

[82] U.S. Census Bureau.

Table A.4. Value-Added, by Industry ($ millions)[83]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**1,973,622**	**1,853,929**	**1,889,290**	**1,923,414**	**2,041,433**	**2,210,349**	**2,285,929**	**2,373,031**
IP-Intensive	***829,051***	***765,510***	***789,733***	***822,375***	***877,200***	***985,742***	***1,013,366***	***1,064,419***
Petroleum and coal products	43,830	47,346	37,076	48,325	66,387	117,986	125,792	124,662
Chemicals	232,652	226,614	256,228	267,318	297,206	331,694	340,038	369,325
Basic chemicals	46,468	37,575	45,712	47,764	61,819	75,168	82,690	87,504
Resin synthentic rubber, fibers	25,891	22,070	22,616	23,966	29,261	34,645	31,494	33,931
Pharmaceuticals and medicines	81,511	91,696	104,300	115,012	118,599	127,639	134,143	143,611
Computer and electronic products	280,095	223,718	200,288	203,194	216,968	227,061	230,762	234,026
Computers and peripheral equipment	43,480	34,394	34,411	30,310	31,793	34,004	35,049	33,647
Communications equipment	62,599	50,756	32,424	30,927	32,094	31,760	36,906	35,037
Semiconductor	105,642	71,289	69,189	73,431	77,512	81,317	76,460	75,495
Navigational, measuring, electromedical	60,543	60,034	56,299	60,349	68,293	73,258	75,808	83,400
Transportation equipment	234,392	227,675	253,415	256,414	250,145	256,558	260,883	282,574
Motor vehicles, trailers, parts	155,979	137,121	167,542	166,748	165,292	161,188	160,007	158,413
Aerospace products and parts	59,534	71,839	64,151	61,797	62,673	72,090	75,906	94,598
Miscellaneous medical equipment	38,082	40,157	42,726	47,124	46,494	52,443	55,891	53,832
Information software	--	--	51,120	--	--	--	73,987	--
Non IP-Intensive	***1,134,480***	***1,098,491***	***1,098,548***	***1,101,029***	***1,164,222***	***1,224,608***	***1,272,564***	***1,308,613***
Food, beverage, tobacco	256,419	270,958	270,170	284,810	298,491	315,823	312,575	320,191
Textiles, apparel, leather	67,652	60,679	54,758	54,703	50,597	53,511	51,240	43,937
Wood products	36,104	33,129	35,121	37,077	43,733	44,752	44,267	41,244
Paper, printing, support activities	141,368	133,519	134,575	129,776	131,910	134,140	140,309	145,584
Plastics and rubber products	91,221	86,557	92,550	92,284	93,150	96,162	99,451	99,940
Nonmetallic mineral products	55,508	53,194	54,764	55,211	59,290	65,032	72,132	72,291
Primary metals	63,282	53,111	57,168	53,642	73,829	75,541	84,343	85,371
Fabricated metal products	138,792	148,874	138,714	137,451	144,994	155,801	169,322	185,885
Machinery	146,053	131,103	129,159	126,706	133,929	143,472	154,460	165,603
Electrical equipment and appliances	62,881	56,304	52,853	51,276	52,921	54,742	57,520	61,755
Furniture and related products	41,823	39,848	42,886	42,152	43,730	46,512	46,390	46,678
Miscellaneous non-medical equipment	33,377	31,215	35,830	35,941	37,648	39,121	40,556	40,134

[83] U.S. Census Bureau.

Table A.5. Exports, by Industry ($ millions)[84]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**644,757**	**597,416**	**563,146**	**577,500**	**642,958**	**711,492**	**821,531**	**910,379**
IP-Intensive	***379,740***	***353,319***	***337,501***	***348,603***	***383,593***	***419,717***	***486,101***	***535,546***
Petroleum and coal products	8,862	8,214	7,897	9,349	12,569	17,788	25,959	30,846
Chemicals	77,649	76,837	78,049	88,384	105,083	114,214	129,504	147,364
Basic chemicals	27,768	26,270	26,019	30,278	36,836	38,995	45,010	51,631
Resin synthentic rubber, fibers	16,227	15,340	15,774	17,052	20,571	23,797	27,329	31,500
Pharmaceuticals and medicines	15,668	18,118	18,708	22,488	27,147	29,104	32,161	36,664
Computer and electronic products	161,636	134,396	116,333	115,948	122,175	124,071	135,025	136,294
Computers and peripheral equipment	44,457	37,291	29,150	27,789	27,123	28,633	29,780	28,908
Communications equipment	18,978	15,550	12,262	10,680	13,521	14,391	14,995	17,514
Semiconductor	65,202	49,829	44,720	47,205	47,592	45,570	49,826	47,834
Navigational, measuring, electromedical	27,106	26,338	24,989	25,683	29,139	30,485	34,895	37,089
Transportation equipment	121,774	123,008	123,970	122,246	129,668	147,244	177,990	202,165
Motor vehicles, trailers, parts	66,846	63,150	66,774	68,510	71,342	77,561	89,803	101,308
Aerospace products and parts	51,499	55,281	53,459	49,675	53,408	63,915	81,194	92,635
Miscellaneous medical equipment	9,505	10,549	10,939	12,352	13,612	15,441	16,616	17,976
Information software	315	315	312	324	486	959	1,007	901
Non IP-Intensive	***265,017***	***244,097***	***225,645***	***228,897***	***259,365***	***291,775***	***335,429***	***374,834***
Food, beverage, tobacco	30,535	30,820	28,734	30,443	29,542	32,249	36,048	42,937
Textiles, apparel, leather	19,671	17,843	16,782	16,395	16,949	17,178	17,320	16,346
Wood products	4,854	3,944	3,777	3,818	4,234	4,445	4,913	4,960
Paper, printing, support activities	20,408	18,912	18,150	18,671	20,089	22,060	23,783	25,947
Plastics and rubber products	16,970	15,745	15,383	15,661	17,264	18,787	20,575	22,259
Nonmetallic mineral products	7,830	7,378	6,025	6,069	6,577	6,911	7,766	8,588
Primary metals	20,126	18,150	15,371	17,877	21,092	27,423	37,079	44,592
Fabricated metal products	21,658	19,525	18,856	18,815	20,732	23,254	27,238	29,800
Machinery	84,780	76,308	70,087	69,220	86,000	96,615	109,364	122,392
Electrical equipment and appliances	25,401	22,764	20,587	20,632	23,558	26,551	31,360	33,463
Furniture and related products	2,882	2,419	2,158	2,349	2,622	2,829	3,158	3,494
Miscellaneous non-medical equipment	9,902	10,288	9,737	8,948	10,705	13,474	16,825	20,056

[84] U.S. International Trade Commission.

Table A.6. Imports, by Industry ($ millions) [85]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**1,045,054**	**976,967**	**1,001,601**	**1,066,513**	**1,236,628**	**1,373,064**	**1,507,428**	**1,573,502**
IP-Intensive	***582,337***	***538,278***	***552,173***	***586,911***	***667,660***	***740,005***	***805,785***	***850,695***
Petroleum and coal products	26,892	26,053	23,054	29,659	42,356	65,149	72,446	80,433
Chemicals	73,999	79,105	85,999	100,635	111,784	127,155	140,601	152,904
Basic chemicals	23,848	24,201	23,896	26,777	30,586	36,405	40,116	42,700
Resin synthentic rubber, fibers	8,901	8,622	8,788	9,801	11,371	14,648	15,461	15,123
Pharmaceuticals and medicines	29,158	33,917	41,220	49,871	53,425	56,983	65,807	72,996
Computer and electronic products	256,270	209,034	210,065	217,486	253,698	275,737	301,073	314,320
Computers and peripheral equipment	70,357	60,375	63,767	65,472	75,537	79,989	85,469	87,977
Communications equipment	31,550	27,575	28,354	30,833	39,384	47,721	51,490	67,698
Semiconductor	99,676	67,866	59,408	58,400	66,861	69,330	76,456	66,781
Navigational, measuring, electromedical	22,160	22,447	23,678	26,440	29,829	32,200	34,847	40,090
Transportation equipment	216,726	214,673	222,335	225,849	244,155	255,186	273,090	282,467
Motor vehicles, trailers, parts	182,928	176,676	189,510	194,551	210,903	219,873	235,082	238,080
Aerospace products and parts	26,858	31,525	26,255	24,345	24,801	26,348	28,939	35,015
Miscellaneous medical equipment	8,284	9,232	10,585	13,158	15,567	16,645	18,489	20,517
Information software	167	179	135	125	100	133	88	54
Non IP-Intensive	***462,717***	***438,690***	***449,428***	***479,602***	***568,967***	***633,059***	***701,643***	***722,807***
Food, beverage, tobacco	16,569	16,187	17,772	19,076	20,547	21,856	23,773	25,359
Textiles, apparel, leather	103,729	102,681	104,917	111,542	120,598	128,917	134,722	138,226
Wood products	16,373	15,994	16,845	17,780	24,488	25,484	24,472	19,975
Paper, printing, support activities	24,407	23,336	23,177	24,500	27,388	29,398	31,088	31,561
Plastics and rubber products	18,608	18,041	19,813	22,041	26,009	30,189	32,834	34,512
Nonmetallic mineral products	16,311	14,974	15,024	16,152	18,686	21,183	23,161	22,105
Primary metals	45,791	38,402	36,360	35,250	58,592	67,086	91,439	91,696
Fabricated metal products	28,743	27,703	29,917	31,632	37,661	43,026	48,389	52,633
Machinery	82,041	74,296	70,956	80,137	97,790	113,143	125,493	128,801
Electrical equipment and appliances	41,432	40,765	41,774	44,445	51,692	58,245	65,559	69,128
Furniture and related products	17,251	16,823	19,257	21,955	25,390	28,345	30,315	30,871
Miscellaneous non-medical equipment	51,461	49,488	53,618	55,091	60,124	66,189	70,397	77,940

[85] U.S. International Trade Commission.

Table A.7. Employment, by Industry[86]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**16,805,479**	**16,303,768**	**14,705,711**	**14,476,258**	**14,150,599**	**13,995,019**	**13,971,516**	**13,666,847**
IP-Intensive	***5,060,828***	***4,977,862***	***4,413,207***	***4,385,995***	***4,298,449***	***4,244,871***	***4,241,921***	***4,178,193***
Petroleum and coal products	109,223	103,570	100,403	98,334	103,927	101,505	102,997	103,577
Chemicals	885,848	869,761	827,430	841,375	823,020	810,368	805,064	793,717
Basic chemicals	191,979	183,249	172,964	170,579	165,209	162,787	161,324	165,025
Resin synthentic rubber, fibers	113,573	107,863	96,808	100,336	93,947	93,102	86,294	88,601
Pharmaceuticals and medicines	227,461	233,503	237,905	251,855	246,297	247,847	249,743	241,339
Computer and electronic products	1,557,087	1,593,307	1,300,411	1,189,485	1,108,339	1,058,992	1,057,485	1,043,288
Computers and peripheral equipment	193,897	199,637	155,137	170,349	125,859	107,020	102,607	99,137
Communications equipment	256,501	269,498	206,255	167,421	151,193	139,178	152,679	151,847
Semiconductor	571,377	603,160	458,945	386,824	373,729	362,182	365,417	362,859
Navigational, measuring, electromedical	461,516	453,496	417,552	403,693	401,333	396,461	384,856	384,966
Transportation equipment	1,872,630	1,753,445	1,578,707	1,606,713	1,625,742	1,636,111	1,622,527	1,574,147
Motor vehicles, trailers, parts	1,198,065	1,087,564	988,398	1,032,461	1,049,744	1,033,204	1,007,939	941,711
Aerospace products and parts	446,243	449,383	391,273	375,169	372,643	387,188	397,933	408,139
Miscellaneous medical equipment	304,555	304,435	294,154	305,850	308,798	310,253	314,015	316,789
Information software	331,485	353,344	312,102	344,238	328,623	327,642	339,833	346,675
Non IP-Intensive	***11,744,651***	***11,325,906***	***10,292,504***	***10,090,263***	***9,852,150***	***9,750,108***	***9,729,595***	***9,488,654***
Food, beverage, tobacco	1,637,484	1,641,010	1,607,161	1,651,159	1,636,964	1,623,963	1,613,831	1,595,380
Textiles, apparel, leather	1,134,057	1,012,821	850,098	790,131	719,252	656,610	598,187	551,185
Wood products	597,684	557,507	534,011	523,984	534,799	555,942	576,506	527,565
Paper, printing, support activities	1,367,332	1,317,771	1,202,409	1,182,453	1,138,199	1,111,725	1,082,441	1,056,867
Plastics and rubber products	1,056,507	1,002,503	925,607	921,392	908,100	902,109	900,842	855,483
Nonmetallic mineral products	523,698	524,230	475,476	467,644	472,133	469,151	482,459	472,128
Primary metals	601,627	572,512	501,038	479,693	451,142	450,811	449,914	438,921
Fabricated metal products	1,790,817	1,761,358	1,582,399	1,518,266	1,514,595	1,519,845	1,563,713	1,565,866
Machinery	1,377,950	1,332,854	1,166,221	1,129,140	1,087,944	1,107,285	1,126,671	1,137,540
Electrical equipment and appliances	589,406	575,413	502,400	459,993	439,064	426,822	419,691	406,259
Furniture and related products	640,444	619,197	575,128	564,414	555,368	547,859	543,259	517,401
Miscellaneous non-medical equipment	427,645	408,730	370,556	401,994	394,590	377,986	372,081	364,059

[86] U.S. Census Bureau.

Table A.8. Production Workers, by Industry[87]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**11,943,646**	**11,235,111**	**10,319,528**	**9,796,581**	**9,365,130**	**9,235,635**	**9,175,328**	**9,296,953**
IP-Intensive	***2,975,007***	***2,783,404***	***2,543,064***	***2,410,684***	***2,292,922***	***2,249,816***	***2,240,573***	***2,300,941***
Petroleum and coal products	67,130	67,487	66,717	65,074	62,713	65,043	65,823	68,272
Chemicals	510,797	499,204	483,205	478,967	438,583	431,502	431,925	463,802
Basic chemicals	109,825	106,047	103,087	99,057	94,676	91,323	91,809	96,470
Resin synthentic rubber, fibers	73,715	67,323	69,178	65,682	58,641	58,385	55,090	67,475
Pharmaceuticals and medicines	116,816	120,350	116,394	119,657	112,828	112,524	113,990	121,966
Computer and electronic products	853,295	779,908	591,268	522,727	476,659	463,683	468,859	497,895
Computers and peripheral equipment	76,543	65,209	49,458	43,007	34,773	35,261	35,186	33,896
Communications equipment	128,948	120,337	72,043	60,040	55,418	51,360	51,448	54,654
Semiconductor	397,169	355,317	258,464	223,285	203,004	197,963	201,460	222,854
Navigational, measuring, electromedical	199,779	192,785	167,919	154,761	147,879	146,427	150,243	158,622
Transportation equipment	1,351,740	1,246,508	1,205,034	1,148,459	1,136,761	1,112,097	1,093,414	1,081,651
Motor vehicles, trailers, parts	954,777	867,975	865,557	813,712	806,424	773,511	750,113	709,272
Aerospace products and parts	229,243	220,756	194,354	191,552	183,291	188,951	191,770	211,686
Miscellaneous medical equipment	192,045	190,297	196,840	195,457	178,206	177,491	180,552	189,321
Information software	--	--	--	--	--	--	--	--
Non IP-Intensive	***8,964,137***	***8,451,705***	***7,776,464***	***7,385,896***	***7,072,206***	***6,985,819***	***6,934,757***	***6,996,012***
Food, beverage, tobacco	1,239,628	1,240,982	1,227,543	1,206,968	1,177,407	1,182,386	1,173,367	1,196,768
Textiles, apparel, leather	949,261	836,009	677,961	611,918	532,791	481,513	442,202	403,025
Wood products	486,245	458,915	441,738	421,725	429,752	431,569	432,428	417,471
Paper, printing, support activities	1,022,056	981,997	890,599	848,686	805,966	786,290	764,838	776,445
Plastics and rubber products	857,415	810,878	767,785	739,847	690,669	686,768	676,107	662,001
Nonmetallic mineral products	407,057	394,573	375,005	361,652	354,445	360,959	368,307	365,926
Primary metals	459,111	420,195	383,592	358,160	342,415	339,832	336,618	344,652
Fabricated metal products	1,375,118	1,296,005	1,168,583	1,110,918	1,081,977	1,081,439	1,110,867	1,179,280
Machinery	914,999	844,059	734,566	697,869	669,200	685,245	693,409	739,449
Electrical equipment and appliances	430,902	395,704	347,683	317,497	305,867	293,749	292,866	296,191
Furniture and related products	513,666	481,531	469,610	435,075	426,270	414,848	404,133	388,495
Miscellaneous non-medical equipment	308,679	290,857	291,799	275,581	255,447	241,221	239,615	226,309

[87] U.S. Census Bureau.

Table A.9. Scientists & Engineers, by Industry (thousands)[88]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**699.6**	**708.0**	**678.5**	**755.9**	**673.2**	**810.7**	**788.8**	**795.1**
IP-Intensive	***552.3***	***548.3***	***531.0***	***590.6***	***503.3***	***639.7***	***629.0***	***625.0***
Petroleum and coal products	2.8	3.0	4.3	3.9	5.1	4.0	4.4	4.9
Chemicals	83.2	81.5	86.9	91.3	117.6	120.0	118.0	128.3
Basic chemicals	12.5	9.3	8.5	0.0	10.3	10.6	9.8	9.6
Resin synthentic rubber, fibers	10.0	11.1	12.8	0.0	9.4	9.4	8.4	8.5
Pharmaceuticals and medicines	43.1	39.6	51.8	56.3	79.8	79.9	81.1	90.5
Computer and electronic products	261.0	267.6	221.5	228.4	245.3	274.0	262.5	241.0
Computers and peripheral equipment	23.6	15.6	15.1	13.8	44.9	45.1	33.1	32.6
Communications equipment	91.8	101.5	52.8	56.0	49.3	49.9	50.4	49.8
Semiconductor	65.4	83.3	73.3	76.0	96.8	97.4	92.4	77.7
Navigational, measuring, electromedical	78.0	63.5	75.9	78.2	0.0	74.6	81.6	75.6
Transportation equipment	109.0	99.5	123.1	144.5	121.8	134.1	135.0	134.7
Motor vehicles, trailers, parts	75.6	73.5	83.2	0.0	88.8	89.0	83.9	89.1
Aerospace products and parts	25.1	19.1	32.5	40.6	28.0	37.9	41.5	37.5
Miscellaneous medical equipment	12.3	15.7	14.4	16.1	13.5	13.9	16.1	17.1
Information software	84.0	81.0	80.8	106.4	0.0	93.7	93.0	99.0
Non IP-Intensive	***147.3***	***159.7***	***151.6***	***140.3***	***170.1***	***173.2***	***159.7***	***170.2***
Food, beverage, tobacco	9.7	13.0	13.9	0.8	16.3	16.4	16.5	16.2
Textiles, apparel, leather	2.1	2.5	2.5	4.0	5.8	5.8	7.8	5.7
Wood products	1.6	2.0	1.5	1.1	1.2	1.0	1.6	1.7
Paper, printing, support activities	12.6	11.1	17.9	16.0	14.5	16.0	8.9	9.7
Plastics and rubber products	12.7	11.5	11.0	11.9	13.9	14.1	11.0	13.5
Nonmetallic mineral products	7.6	6.9	7.0	6.1	6.4	6.5	6.7	6.9
Primary metals	4.6	4.7	4.0	4.1	4.8	4.9	3.8	3.4
Fabricated metal products	10.9	10.1	13.1	13.5	15.4	15.7	16.7	22.1
Machinery	53.9	55.9	56.5	55.3	61.9	62.6	59.6	65.0
Electrical equipment and appliances	24.3	33.6	14.0	16.4	19.2	19.4	17.9	15.9
Furniture and related products	3.0	2.2	2.0	2.6	2.9	2.9	3.6	3.1
Miscellaneous non-medical equipment	4.3	6.2	8.2	8.5	7.8	7.9	5.6	7.0

[88] U.S. Census Bureau.

Table A.10. Employment Wages, by Industry ($ thousands)[89]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**688,043,804**	**654,654,043**	**610,286,382**	**611,527,637**	**627,696,256**	**634,679,071**	**658,017,039**	**669,121,972**
IP-Intensive	***287,430,044***	***270,490,849***	***246,195,888***	***250,623,173***	***246,493,979***	***258,243,026***	***269,448,827***	***278,109,893***
Petroleum and coal products	6,385,725	6,335,924	6,456,421	6,486,710	7,776,369	8,201,183	8,151,453	8,510,322
Chemicals	45,609,549	46,394,786	46,430,565	48,532,339	48,815,585	49,209,739	51,083,557	51,483,409
Basic chemicals	10,878,343	10,771,035	10,517,022	10,593,956	10,648,103	10,831,883	10,996,767	11,619,628
Resin synthentic rubber, fibers	5,977,426	5,660,077	5,296,180	5,454,969	5,218,252	5,390,768	5,249,541	5,623,367
Pharmaceuticals and medicines	13,276,262	14,585,333	15,878,156	17,414,292	17,682,610	18,091,705	19,387,512	18,915,925
Computer and electronic products	90,397,471	84,522,217	71,698,438	66,583,405	66,317,909	65,601,082	69,825,765	72,846,864
Computers and peripheral equipment	11,812,969	11,372,337	9,549,212	9,415,385	8,111,388	7,049,151	6,943,174	7,405,654
Communications equipment	17,433,245	16,175,149	13,346,435	10,611,009	9,712,590	9,498,683	12,282,708	13,861,046
Semiconductor	31,940,683	28,296,971	21,932,669	19,369,654	20,159,643	20,093,667	21,012,647	21,414,910
Navigational, measuring, electromedical	26,495,638	26,071,991	24,255,795	24,797,329	25,997,765	26,467,359	27,175,043	28,013,002
Transportation equipment	88,631,732	83,439,891	78,771,473	79,966,831	85,128,294	86,006,495	86,459,228	85,876,304
Motor vehicles, trailers, parts	55,274,811	48,954,274	47,508,612	49,724,941	52,281,702	51,077,033	49,511,804	47,037,244
Aerospace products and parts	25,026,371	26,204,849	23,250,070	22,306,143	24,419,208	25,965,690	27,659,514	28,725,435
Miscellaneous medical equipment	12,315,561	12,843,366	12,908,614	13,584,148	3,589,404	15,241,761	16,135,396	16,800,952
Information software	44,090,006	36,954,665	29,930,377	35,469,740	34,866,418	33,982,766	37,793,428	42,592,042
Non IP-Intensive	***400,613,760***	***384,163,194***	***364,090,494***	***360,904,464***	***381,202,277***	***376,436,045***	***388,568,212***	***391,012,079***
Food, beverage, tobacco	51,090,849	51,343,292	51,634,204	53,703,609	54,750,495	55,737,455	57,771,786	58,779,791
Textiles, apparel, leather	26,992,151	24,220,319	22,142,038	20,692,162	19,891,403	18,027,831	17,178,526	16,415,646
Wood products	16,511,396	15,829,400	15,922,366	15,891,255	17,193,541	18,232,348	18,583,842	17,507,375
Paper, printing, support activities	51,609,428	49,551,741	46,875,104	46,701,111	46,587,294	46,620,123	46,991,115	47,009,776
Plastics and rubber products	34,110,098	32,641,356	32,036,051	32,126,293	33,159,597	33,391,197	34,075,394	33,477,683
Nonmetallic mineral products	19,122,634	19,349,947	18,119,656	18,087,488	18,962,914	19,691,409	20,598,480	20,380,239
Primary metals	25,544,619	23,641,904	21,623,206	20,862,861	21,485,650	22,108,497	22,783,899	22,854,115
Fabricated metal products	64,244,450	61,803,349	57,681,542	55,777,932	58,580,632	60,693,213	64,905,442	67,400,836
Machinery	58,386,691	54,713,649	50,101,357	48,993,556	50,459,221	52,652,677	55,289,135	56,797,227
Electrical equipment and appliances	21,852,991	20,873,387	18,849,367	17,617,006	17,797,232	17,885,134	18,416,031	18,545,383
Furniture and related products	17,963,631	17,433,649	16,806,059	16,795,903	17,221,357	17,560,322	17,897,080	17,491,840
Miscellaneous non-medical equipment	13,184,822	12,761,201	12,299,544	13,655,288	25,112,941	13,835,839	14,077,482	14,352,168

[89] U.S. Census Bureau.

Table A.11. Production Worker Wages, by Industry ($ thousands)[90]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**363,380,819**	**342,990,489**	**336,540,063**	**330,480,113**	**332,873,474**	**337,980,878**	**344,192,729**	**350,370,166**
IP-Intensive	***115,085,058***	***107,166,530***	***105,566,682***	***103,811,444***	***104,025,300***	***104,593,557***	***105,528,301***	***108,398,006***
Petroleum and coal products	3,434,058	3,519,479	3,760,210	3,928,494	4,131,341	4,585,183	4,668,463	4,872,281
Chemicals	20,449,205	20,465,946	21,122,027	21,370,845	20,891,922	21,382,514	21,724,797	23,157,383
Basic chemicals	5,524,264	5,562,460	5,634,371	5,512,900	5,647,143	5,554,246	5,679,133	6,133,036
Resin synthetic rubber, fibers	3,435,320	3,171,019	3,270,182	3,140,422	3,047,034	3,168,574	3,048,751	3,391,858
Pharmaceuticals and medicines	4,467,295	4,763,747	4,995,345	5,294,639	5,134,679	5,451,007	5,706,371	6,085,139
Computer and electronic products	28,335,262	26,372,081	20,967,255	19,140,588	18,372,759	18,606,274	19,070,872	20,748,167
Computers and peripheral equipment	2,766,986	2,416,799	1,914,188	1,824,265	1,538,547	1,472,603	1,393,957	1,314,210
Communications equipment	4,795,683	4,476,308	2,572,438	2,060,044	2,137,376	2,091,774	2,110,219	2,379,204
Semiconductor	11,996,311	10,783,324	8,688,797	7,740,251	7,224,678	7,370,943	7,721,618	8,910,117
Navigational, measuring, electromedical	7,388,170	7,388,082	6,546,773	6,242,953	6,309,379	6,599,586	6,811,635	7,229,366
Transportation equipment	57,732,157	51,551,334	53,885,838	53,572,879	54,714,094	53,900,796	53,709,079	53,251,991
Motor vehicles, trailers, parts	41,497,986	35,953,817	38,548,044	38,353,259	39,225,254	37,357,169	36,543,194	34,617,964
Aerospace products and parts	11,005,882	10,529,087	10,441,886	10,203,107	10,345,136	11,201,608	11,418,911	12,099,754
Miscellaneous medical equipment	5,134,376	5,257,690	5,831,352	5,798,638	5,915,184	6,118,790	6,355,090	6,368,184
Information software	--	--	--	--	--	--	--	--
Non IP-Intensive	***248,295,759***	***235,823,960***	***230,973,381***	***226,668,670***	***228,848,174***	***233,387,321***	***238,664,428***	***241,972,160***
Food, beverage, tobacco	31,360,825	31,894,308	33,654,346	34,156,031	34,518,003	35,614,707	36,296,911	38,385,971
Textiles, apparel, leather	18,173,833	16,115,681	14,209,081	13,403,557	12,320,693	11,536,098	10,810,999	9,618,644
Wood products	11,752,286	11,135,413	11,554,993	11,349,849	12,174,518	12,618,535	12,794,805	12,086,052
Paper, printing, support activities	32,939,179	31,973,451	30,562,319	29,928,765	29,555,808	29,510,458	29,791,120	30,046,242
Plastics and rubber products	22,702,808	21,683,010	21,879,554	21,844,838	21,747,048	22,093,527	21,973,054	21,701,723
Nonmetallic mineral products	12,910,253	12,554,146	12,525,866	12,521,398	12,745,717	13,414,565	14,143,118	13,857,656
Primary metals	17,620,708	15,984,531	15,433,857	14,634,718	15,446,378	15,658,322	16,030,894	16,305,411
Fabricated metal products	40,071,886	37,880,635	36,572,357	35,987,805	36,729,954	38,033,694	40,235,991	42,491,970
Machinery	29,767,872	27,413,602	25,438,067	24,813,155	25,144,009	26,399,769	27,587,649	28,944,114
Electrical equipment and appliances	12,067,797	11,164,038	10,285,641	9,712,027	9,897,822	9,880,005	10,074,217	10,435,588
Furniture and related products	11,821,683	11,207,663	11,574,876	11,127,942	11,488,962	11,642,410	11,746,266	11,338,607
Miscellaneous non-medical equipment	7,106,629	6,817,482	7,282,424	7,188,585	7,079,262	6,985,231	7,179,404	6,760,182

[90] U.S. Census Bureau.

Table A.12. Capital Expenditure, by Industry ($ millions)[91]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**159,183**	**148,546**	**126,124**	**115,899**	**116,788**	**131,207**	**140,056**	**161,910**
IP-Intensive	***78,142***	***75,710***	***59,267***	***57,451***	***55,563***	***65,048***	***66,451***	***81,586***
Petroleum and coal products	5,225	7,347	5,932	7,391	7,229	11,049	11,832	18,024
Chemicals	20,340	18,852	17,808	15,588	16,654	16,857	17,665	24,342
Basic chemicals	6,499	5,579	4,870	4,060	4,552	5,153	6,134	9,662
Resin synthentic rubber, fibers	3,116	2,426	2,571	1,982	2,132	2,661	2,816	3,456
Pharmaceuticals and medicines	5,693	6,438	5,780	5,947	6,697	5,520	5,172	6,778
Computer and electronic products	28,059	25,505	13,642	12,596	11,993	16,359	14,782	15,283
Computers and peripheral equipment	2,501	1,887	2,419	1,994	1,248	1,354	1,672	1,433
Communications equipment	3,988	4,758	1,660	1,494	1,129	1,047	2,041	1,519
Semiconductor	17,468	14,559	6,363	5,496	6,297	9,665	7,128	8,409
Navigational, measuring, electromedical	3,232	3,480	2,650	3,085	2,722	3,803	3,230	3,286
Transportation equipment	17,608	16,717	16,611	16,204	14,348	15,322	15,177	15,232
Motor vehicles, trailers, parts	14,229	13,355	12,683	12,974	11,387	11,434	11,329	10,787
Aerospace products and parts	2,326	2,449	2,842	2,389	2,164	2,981	2,889	3,125
Miscellaneous medical equipment	2,205	2,396	2,217	1,949	2,345	2,544	2,741	2,571
Information software	4,704	4,894	3,057	3,723	2,995	2,915	4,255	6,134
Non IP-Intensive	***81,041***	***72,835***	***66,857***	***58,448***	***61,225***	***66,159***	***73,605***	***80,323***
Food, beverage, tobacco	14,961	14,312	14,300	13,578	13,928	15,414	15,954	16,388
Textiles, apparel, leather	3,677	3,084	2,420	1,867	1,745	1,888	1,903	1,905
Wood products	3,079	2,712	2,414	2,136	2,704	3,034	3,608	3,036
Paper, printing, support activities	11,801	10,862	10,126	9,471	9,171	9,832	11,652	11,218
Plastics and rubber products	8,404	7,341	7,354	6,301	6,518	6,716	7,152	7,534
Nonmetallic mineral products	5,972	5,687	5,203	4,630	4,606	5,161	6,263	7,776
Primary metals	6,138	5,140	4,283	3,301	3,921	4,531	5,191	7,471
Fabricated metal products	9,992	8,633	7,912	6,661	7,209	7,706	8,340	10,539
Machinery	9,267	8,322	6,662	5,537	6,037	6,658	7,398	8,049
Electrical equipment and appliances	3,855	3,391	2,687	2,212	2,213	1,922	2,581	2,922
Furniture and related products	2,053	1,578	1,732	1,359	1,296	1,406	1,525	1,545
Miscellaneous non-medical equipment	1,842	1,773	1,765	1,394	1,878	1,892	2,039	1,942

[91] U.S. Census Bureau.

Table A.13. Capital Expenditure:Machinery & Equipment, by Industry ($ millions)[92]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**133,995**	**120,863**	**105,367**	**98,957**	**99,359**	**112,171**	**120,631**	**130,946**
IP-Intensive	***64,064***	***58,391***	***48,476***	***48,295***	***46,106***	***54,785***	***56,297***	***65,438***
Petroleum and coal products	4,564	4,408	4,774	6,357	6,151	9,727	10,446	14,998
Chemicals	16,837	15,169	14,466	12,948	13,283	13,982	14,593	19,497
Basic chemicals	6,069	5,229	4,312	3,778	4,117	4,627	5,614	8,261
Resin synthentic rubber, fibers	2,859	2,216	2,300	1,805	1,982	2,444	2,586	3,174
Pharmaceuticals and medicines	3,683	3,996	3,987	4,253	4,454	3,880	3,390	4,506
Computer and electronic products	22,397	19,149	11,096	10,582	9,996	13,389	12,623	12,200
Computers and peripheral equipment	2,151	1,673	1,791	1,475	1,135	1,107	1,538	1,131
Communications equipment	3,391	3,438	1,256	1,202	905	807	1,542	976
Semiconductor	13,544	10,901	5,438	5,045	5,466	8,077	6,419	7,087
Navigational, measuring, electromedical	2,544	2,421	2,122	2,363	1,982	2,970	2,583	2,436
Transportation equipment	14,935	14,402	14,039	14,071	12,394	13,100	13,140	12,690
Motor vehicles, trailers, parts	12,421	11,771	10,938	11,597	10,209	10,531	10,313	9,355
Aerospace products and parts	1,814	1,944	2,259	1,764	1,548	1,865	2,148	2,338
Miscellaneous medical equipment	1,734	1,899	1,758	1,650	1,909	2,073	2,183	1,973
Information software	3,596	3,364	2,343	2,687	2,373	2,513	3,312	4,080
Non IP-Intensive	***69,931***	***62,472***	***56,892***	***50,662***	***53,216***	***57,385***	***64,335***	***65,508***
Food, beverage, tobacco	12,383	11,721	11,603	11,126	11,385	12,455	13,188	12,286
Textiles, apparel, leather	3,232	2,702	2,093	1,669	1,506	1,595	1,607	1,583
Wood products	2,534	2,291	2,030	1,872	2,243	2,505	3,101	2,447
Paper, printing, support activities	10,773	9,849	8,895	8,543	8,418	9,003	10,530	9,822
Plastics and rubber products	7,512	6,473	6,447	5,666	5,871	6,048	6,510	6,410
Nonmetallic mineral products	5,117	4,794	4,426	3,975	4,053	4,595	5,496	6,497
Primary metals	5,266	4,297	3,838	2,901	3,600	4,149	4,769	5,753
Fabricated metal products	8,801	7,697	6,784	5,839	6,228	6,822	7,451	8,864
Machinery	7,703	6,853	5,613	4,730	5,255	5,848	6,428	6,636
Electrical equipment and appliances	3,399	2,995	2,272	1,986	2,002	1,709	2,315	2,422
Furniture and related products	1,649	1,274	1,405	1,131	1,022	1,093	1,218	1,241
Miscellaneous non-medical equipment	1,563	1,524	1,487	1,226	1,633	1,563	1,720	1,546

[92] U.S. Census Bureau.

Table A.14. Capital Expenditure: Buildings & Other Structures, by Industry ($ millions)[93]

	2000	2001	2002	2003	2004	2005	2006	2007
All Tradable Industries	**25,188**	**27,682**	**20,756**	**16,941**	**17,429**	**19,036**	**19,425**	**30,964**
IP-Intensive	***14,079***	***17,319***	***10,791***	***9,155***	***9,457***	***10,263***	***10,154***	***16,148***
Petroleum and coal products	661	2,939	1,158	1,034	1,078	1,322	1,386	3,026
Chemicals	3,503	3,683	3,342	2,639	3,371	2,875	3,072	4,845
Basic chemicals	430	349	557	281	435	526	520	1,401
Resin synthentic rubber, fibers	257	210	271	177	149	217	230	282
Pharmaceuticals and medicines	2,010	2,442	1,793	1,694	2,242	1,640	1,783	2,271
Computer and electronic products	5,662	6,356	2,546	2,014	1,996	2,970	2,159	3,083
Computers and peripheral equipment	351	215	628	519	113	246	134	302
Communications equipment	597	1,319	404	293	224	241	499	543
Semiconductor	3,924	3,658	925	451	831	1,588	708	1,322
Navigational, measuring, electromedical	688	1,059	528	722	740	833	648	850
Transportation equipment	2,673	2,314	2,572	2,133	1,954	2,222	2,037	2,542
Motor vehicles, trailers, parts	1,808	1,584	1,745	1,378	1,179	902	1,016	1,432
Aerospace products and parts	512	505	584	625	616	1,116	741	787
Miscellaneous medical equipment	472	497	459	299	435	472	558	598
Information software	1,108	1,530	714	1,036	622	402	943	2,054
Non IP-Intensive	***11,109***	***10,363***	***9,965***	***7,786***	***8,010***	***8,774***	***9,270***	***14,816***
Food, beverage, tobacco	2,578	2,591	2,697	2,453	2,543	2,959	2,766	4,102
Textiles, apparel, leather	446	382	327	198	239	294	295	321
Wood products	545	421	384	264	461	529	507	589
Paper, printing, support activities	1,028	1,012	1,231	928	753	829	1,121	1,396
Plastics and rubber products	891	868	906	635	647	668	642	1,124
Nonmetallic mineral products	855	893	777	655	553	566	768	1,279
Primary metals	873	843	445	399	321	381	422	1,717
Fabricated metal products	1,191	936	1,128	823	982	884	889	1,674
Machinery	1,565	1,469	1,049	807	782	809	970	1,412
Electrical equipment and appliances	457	396	415	226	211	213	266	499
Furniture and related products	404	304	327	229	274	313	306	304
Miscellaneous non-medical equipment	279	248	279	169	245	328	318	396

[93] U.S. Census Bureau.

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